CENTRAL SURGICAL ASSOCIATION NUMBER

Vol. 20 AUGUST, 1946 No. 2

SURGERY

A Monthly Journal Devoted to the Art and Science of Surgery

EDITORS

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CONTENTS

Original Communications

Central Surgical Association

President's Address. The Surgeon—An Individualist. Roscoe R. Graham, M.B., Toronto, Canada ---- 163

Massive Organizing Hemothorax. Lieutenant Colonel August E. Jonas, Medical Corps, Army of the United States ---- 168

Further Experiences in the Surgical Treatment of Congenital Atresia of the Esophagus With Tracheoesophageal Fistula. Conrad R. Lam, M.D., Detroit, Mich. 174

Postoperative Pulmonary Embolism. J. J. Smyth, M.D., and M. G. Gillespie, M.D., Duluth, Minn. ---- 180

Management of Pulmonary Abscess. Francis M. Woods, M.D., and Edward J. McGrath, M.D., Cincinnati, Ohio ---- 187

Acute Secondary Parotitis. W. A. Altemeier, M.D., Cincinnati, Ohio ---- 191

Curare—Its Rational Use as an Adjunct to Anesthesia. Stuart C. Cullen, M.D., Iowa City, Iowa ---- 200

The Role of Cancellous Bone in Plastic Surgery. Stuart Gordon, M.B., M.S.(T.), M.D., Toronto, Canada ---- 202

A Method in the Management of Multiple Facial Fractures. H. Hoyle Campbell, M.D., Toronto, Canada ---- 204

Tardy Median Palsy; Median Neuritis; Median Thenar Neuritis Amenable to Surgery. Bland W. Cannon, M.D., and J. Grafton Love, M.D., Rochester, Minn. ---- 210

Fundamentals of Technique in the Transverse Abdominal Incision. Fraser N. Gurd, M.D., C.M., Montreal, Canada ---- 217

Resection of the Duodenum and Head of the Pancreas for Carcinoma. John M. Waugh, M.D., and O. Theron Clagett, M.D., Rochester, Minn. ---- 224

Value of the Exclusion Operation in the Treatment of Intestinal Fistulas. J. G. Probstein, M.D., St. Louis, Mo. ---- 233

Reconstruction of War Wounds of Colon and Rectum. Lieutenant Colonel Joseph E. Hamilton and Major Lachlan M. Cattanach, Medical Corps, Army of the United States ---- 237

Transverse Colostomy. Laurence Sidney Fallis, M.D., Detroit, Mich. ---- 249

Radical Perineal Prostatectomy for Carcinoma of Prostate. John K. Ormond, M.D., Detroit, Mich. ---- 257

Prostatic Carcinoma. Reed M. Nesbit, M.D., and Robert T. Plumb, M.D., Ann Arbor, Mich. ---- 263

Malignant Testicular Neoplasms. Reed M. Nesbit, M.D., and Jack M. Lynn, M.D., Ann Arbor, Mich. ---- 273

(Continued on Inside Cover)

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(Continued from Front Cover)

Novocain Infiltration in the Treatment of Acute Ankle Injuries Without Fracture. Charles W. McLaughlin, Jr., M.D., Omaha, Neb. ---- 280

Metabolic Alterations Following Thermal Burns. VI. The Effect of Altering the Nitrogen and Caloric Intake or of Administering Testosterone Propionate on the Nitrogen Balance. William E. Abbott, M.D., John Winslow Hirshfeld, M.D., Harold H. Williams, Ph.D., Matthew A. Pilling, M.D., and Frieda L. Meyer, Ph.D., Detroit, Mich. ---- 284

Review of Recent Meetings

Meeting of the Central Surgical Association. Henry K. Ransom, M.D., Ann Arbor, Mich. ---- 295

Book Reviews

Book Reviews ---- 312
Books Received ---- 312

Articles to appear in early issues of SURGERY

CONGENITAL ESOPHAGEAL ATRESIA WITH TRACHEOESOPHAGEAL FISTULA.
By M. Lawrence White, Jr., M.D., and McLemore Birdsong, M.D., Charlottesville, Va.

AIR BLAST EFFECT IN A CAVE.
By Captain W. B. Shelley, Medical Corps, and Major S. M. Horvath, Sanitary Corps, Army of the United States.

TREATMENT OF EXEMITIES FOLLOWING SUDDEN FAILURE OF CIRCULATION.
By Gordon Murray, M.D., J. S. Simpson, M.D., and N. A. Watters, M.D., Toronto, Canada.

BILATERAL POPLITEAL HERNIA.
By Allan E. Sachs, M.D., and Lawrence Rubinstein, M.D., Chicago, Ill.

THE EFFECT OF ATROPINE ON THE GASTRIC SECRETION FOLLOWING THERMAL TRAUMA.
By H. Necheles, M.D., Ph.D., E. Prescott, and William H. Olson, Chicago, Ill.

TWO UNUSUAL CASES OF WAR WOUNDS OF THE HEART.
By Lieutenant Colonel Paul C. Samson, Medical Corps, Army of the United States.

A METHOD FOR THE CHEMICAL PRODUCTION OF A PROLONGED SYMPATHETIC PARALYSIS.
By Major Theodore B. Rasmussen, and Captain Alfred A. Alessi, Medical Corps, Army of the United States.

TENON AND MORTISE GRAFTS FOR BRIDGING METACARPAL DEFECTS DUE TO GUNSHOT WOUNDS.
By Lieutenant Colonel Harry D. Morris, Medical Corps, Army of the United States.

TRAUMATIC ANEURYSMS.
By Lieutenant Colonel Hollis L. Albright and Major Laurence A. Van Hale, Medical Corps, Army of the United States.

TREATMENT OF NONUNION OF THE CARPAL NAVICULAR BONE.
By Major C. J. Sutro, Medical Corps, Army of the United States.

THE SPLIT-THICKNESS SKIN GRAFT AS A COVERING FOLLOWING REMOVAL OF A FINGERNAIL.
By Edward M. Hanrahan, M.D., Baltimore, Md.

SURGICAL REMOVAL OF LARGE RETROPERITONEAL LUMBAR GANGLIONEUROMA.
By Roland P. Reynolds, M.D., and Meyer O. Cantor, M.D., Detroit, Mich.

HYDRONEPHROSIS. IV. THE SURGICAL TREATMENT.
By Frank Hinman, M.D., San Francisco, Calif.

Vol. 20, No. 2, August, 1946, Surgery is published monthly by The C. V. Mosby Company, 3207 Washington Blvd., St. Louis 3, Mo. Subscription price: United States, its possessions, Pan-American Countries, $10.00 a year; Canada, $11.50 (Canadian Currency); Foreign, $11.00. Entered as Second-Class Matter January 20, 1937, at the Post Office at St. Louis, Missouri, under the Act of March 3, 1879. Printed in U. S. A.

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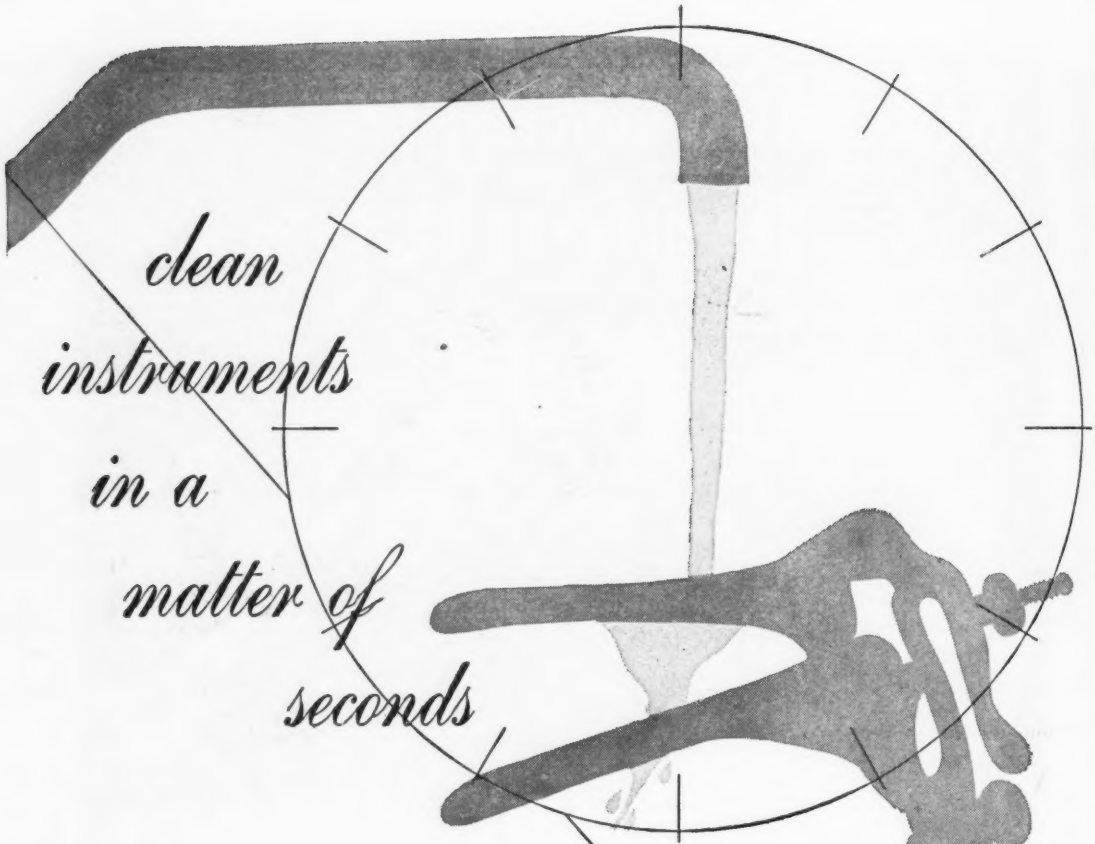

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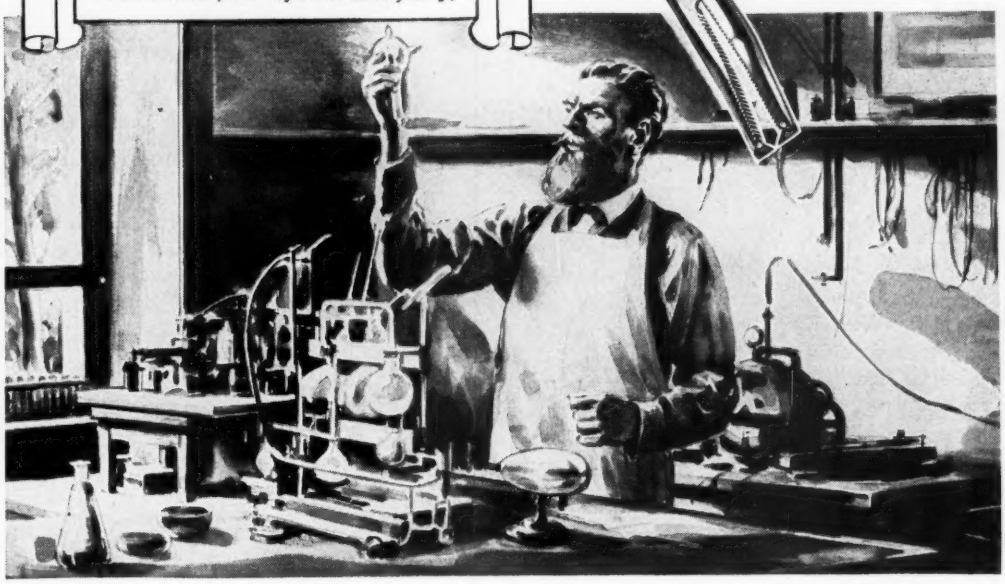

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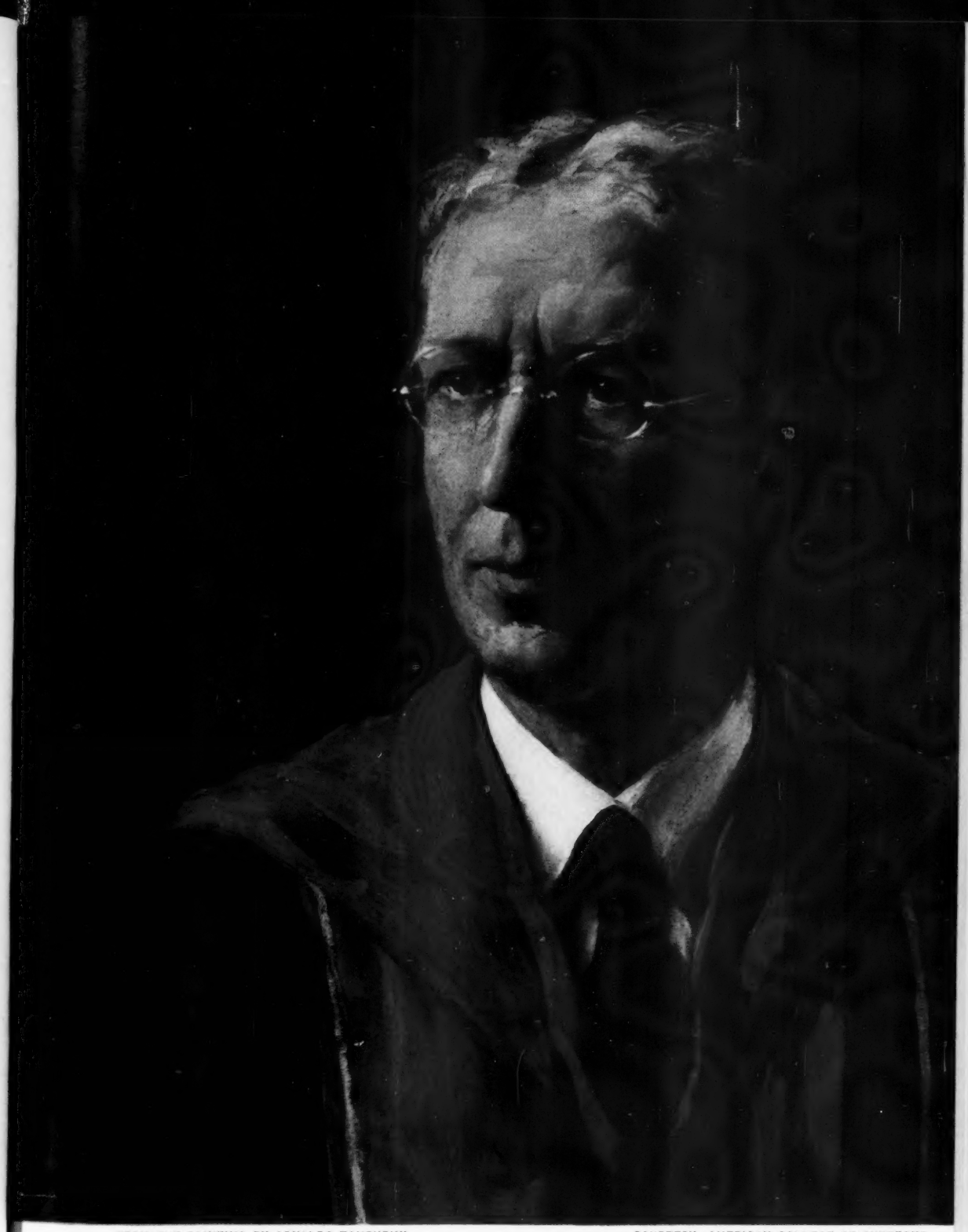

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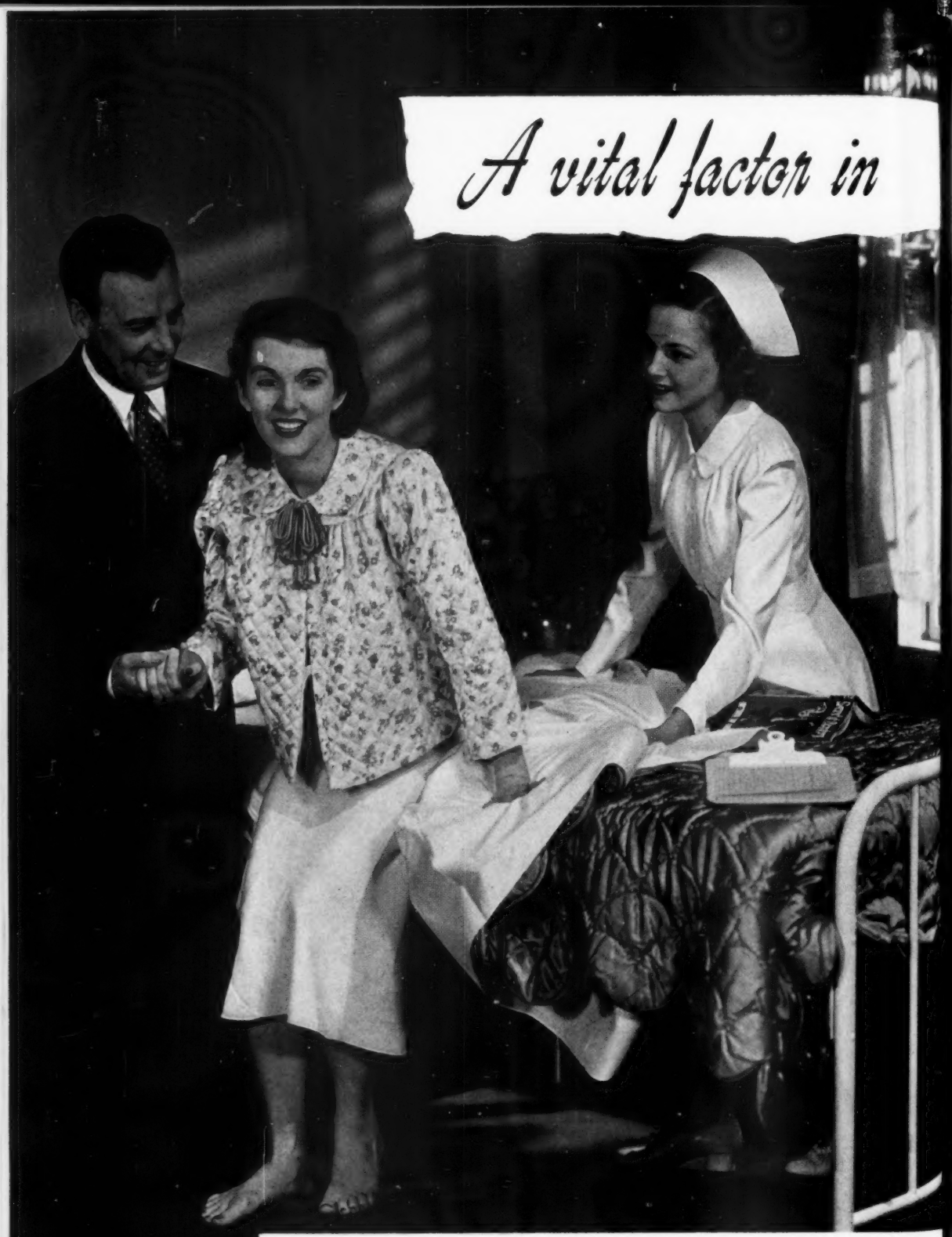

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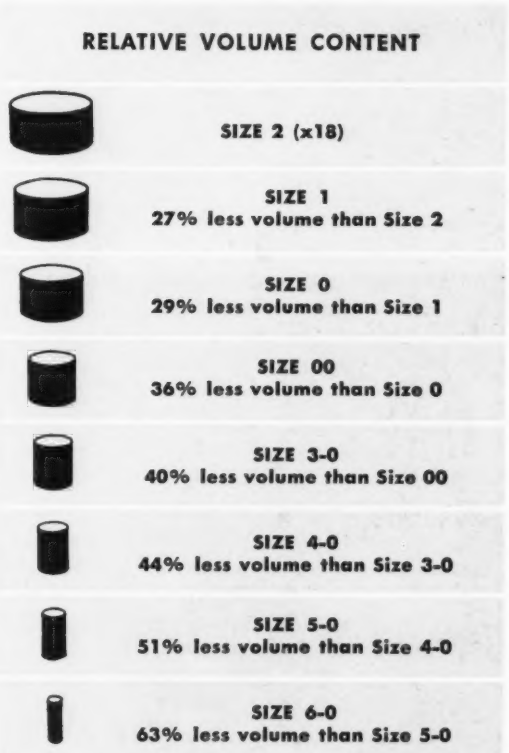

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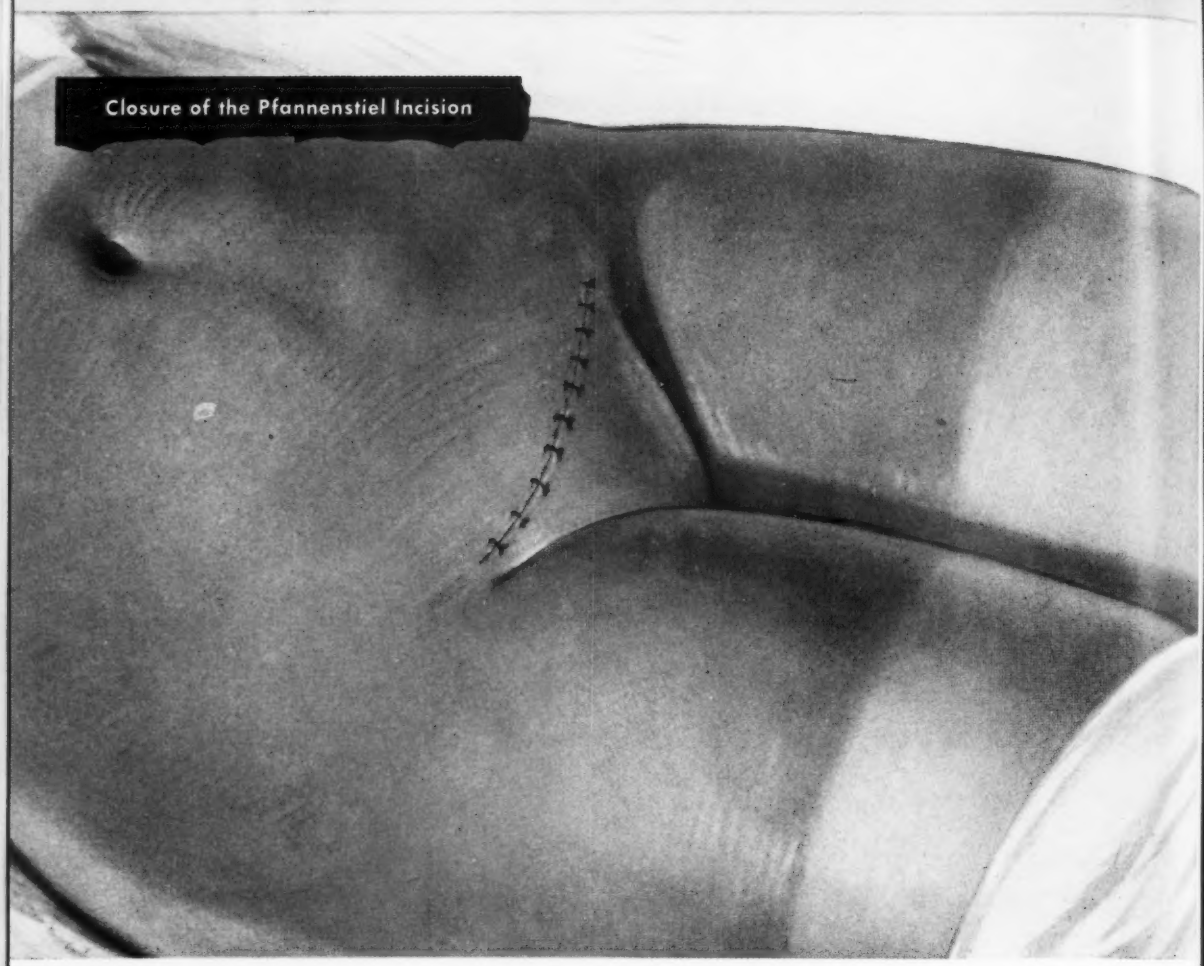

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SURGERY

VOL. 20 AUGUST, 1946 NO. 2

Original Communications

Central Surgical Association

PRESIDENT'S ADDRESS

THE SURGEON—AN INDIVIDUALIST

ROSCOE R. GRAHAM, M.B., TORONTO, CANADA

THE restoration of peace makes possible this meeting of the Central Surgical Association. The members of the Association are deeply indebted to Dr. Roy McClure for his vision and energy, which resulted in the formation of this group. The Association provides a medium for the expression of individual thought and opinion. That we are able to meet in an environment where individual opinions may be freely expressed makes us conscious of a great responsibility, which must be accepted by all. The policy of the program committee, which limits the presentation of papers to ten minutes, has shown that few subjects have suffered from this brevity. The enthusiasm of the essayists and the quality of the material presented indicate that the members of this group realize, and are discharging, their responsibilities as individuals at a time when the ramifications of scientific endeavor and the care of sick people tend to collectivism rather than to individualism.

The desire, uttered or unexpressed, that today lies deep in every heart may be summed up in these words—"peace with security." The desire for peace is common to all civilized peoples. Those of us who have been denied active participation in the recent conflict must assume the great responsibility of establishing peace with security for the returned personnel, as well as for ourselves. We must accept this task as individuals, as well as collectively.

In order that we may discharge this obligation to the greatest possible degree, it becomes wise to analyze the underlying urge which leads individuals to wish for peace with security, rather than to lead exciting but uncertain lives, with a daily challenge to one's resourcefulness and initiative. During the last six years the wanton waste of men and materials, with the often unpredictable outcome of major engagements, makes the desire for peace and security a

Presented at the Third Annual Meeting of the Central Surgical Association, Chicago, Ill., Feb. 22-23, 1946.

most desirable and logical goal. The war has destroyed what we had come to consider as irrevocable standards governing our daily lives. It has been impossible as yet to replace these with new ones. This combination of circumstances has resulted in a sense of frustration and mental chaos for many individuals, leading to an attitude of laissez faire, with a sense of hopelessness of the value of individual effort. Such individuals are content to accept whatever someone else will formulate for them. They have ceased as individuals to contribute to the solution of the daily problems. However, we must not forget the role of individual effort in the development of this country. In the early settlements these rugged pioneers, with sturdy physiques, robust health, personal integrity, and indefatigable industry, solely through their individual efforts were able to achieve for themselves at the end of life's journey—peace with security. Further, their freedom from frustration along the road of life was such that should one be so unfortunate as to fall during the struggle for the ultimate goal, there still would have been an interesting and satisfying existence. The daily life would be filled with the pride of achievement which results from the completion of the tasks which had been assigned by others or by themselves.

During this same era there was a similar individuality in the practice of surgery. For this rugged and courageous individual who represented the surgeon of earliest times there was a similar satisfaction from the pride of achievement. In the early phases of surgical endeavor, the individual was concerned largely with the amputation of mutilated extremities or the control of hemorrhage, the result of trauma, largely produced by war. The methods were crude and the results disappointing, judged by today's standards, but they represented the best efforts of the individual of that time.

The next advance in surgical endeavor had to do with operative procedures dealing with obvious and visible deformities, swellings and tumors in individuals otherwise well. This introduced the elective surgical procedure into medical practice. Great individual courage was demanded of the surgeon who during this era would suggest and carry out an elective operation.

The individual who probably did more for human suffering than any other single person was also a surgeon, Joseph Lister. Working quietly, and not without opposition, he gave to the world safety for surgical procedures which hitherto had carried a forbidding mortality and morbidity. Into this picture next came Wilhelm Konrad Roentgen, who in 1895 discovered the x-ray, which has so greatly enlarged the entire field of medical and surgical endeavor. Here again we profit from the result of individual effort. With this new physical aid to diagnosis the necessity for cooperation between the fundamental scientists and the surgeons becomes imperative. The tremendous advance which followed the application of x-rays to the diagnosis and treatment of human ills necessitated the discarding of all former criteria of medical and surgical achievement and their replacement by new standards. These standards have further been modified by the increasing contributions from the fundamental sciences, notably biochemistry and physiology. These contributions have largely been the result of an individual's effort. While many have contributed to the present excellence

of insulin therapy, insulin as such resulted from the individual effort of Sir Frederick Banting.

These contributions have evolved methods of therapy which can now alter the functional and physiologic response of apparently normal anatomic structures. Indeed, such surgical procedures are now being carried out on both the central and the peripheral nervous systems.

We realize that while individual initiative has been of prime importance throughout the evolution of surgical practice and operative procedures, it is now becoming more imperative that the fullest co-operation exist between the various branches of medical science, in order that the greatest benefit may accrue to the individual patient. At the turn of the century the physician and the surgeon reached the pinnacle of practice as individuals. The facilities which are now available for the investigation and the care of the sick patient enable us to detect and determine subtle departures from the physiologic normal, which to our predecessors would seem nothing short of miraculous.

The war has made contributions to surgical therapy by virtue of necessity. The recent evolution of chemotherapy and the development of resuscitation measures are possible as a result of the diligent effort and research by individuals during the prewar era. The accumulation of many brilliant individual contributions over the years has created a storehouse of resources and knowledge upon which we rely for aid in the care of human ills. Now, however, it becomes obvious that no matter how great an individualist a surgeon may be, he cannot solely by his own efforts do all that is possible for his patients. He must, while retaining his individuality, cooperate closely with his colleagues, and contribute his quota to the storehouse of knowledge from which he has been permitted to draw so freely.

We are now faced, to a degree unprecedented in recorded history, with the necessity of establishing new standards of human relations. Particularly is this true in the care of the sick. We of the medical profession can appreciate, to some degree at least, the necessity for, and the implications of, such changes in the necessarily new standards of practice as they will affect our efforts. One is staggered, however, in contemplating the changes in the accepted standards and the effect upon human behavior which must result from the modifications of government, religious freedom, and social security, which at the moment appear inevitable. The trend during the last decade has been definitely from individualism to collectivism. To some this change may be a source of resentment. It disturbs and dislocates a way of life which had been found to be satisfying and happy, and which led to peace with security. During World War II, all accepted graciously any changes in our standards which were necessary for the effective conduct of the war effort. We must, however, bear in mind that, while such changes were achieved by the unifying effect of mass reaction during the war, this stimulus is absent now that the war is ended. Let us hope, however, that the individual will not disregard his responsibility to aid in the setting up of the new postwar standards by relegating such problems solely to committees and governments.

After a calm survey, even those who resent these changing standards must realize that the continued practice of rugged individualism could not fulfill in our profession the highest achievements of which we are capable. This necessity for the application of the contributions from the basic sciences to the diagnosis and treatment of everyday ills very greatly complicates the care of the sick. As a result there must be a closer association of the individual members of our profession, each of whom must bring to bear to the problem in hand a definite contribution. The multiplicity of individuals necessary to deal adequately with a single clinical problem creates for the patient a great economic burden. As a result, a modification of the procedures which govern the conduct of organized medicine becomes imperative. The necessary clinical and laboratory investigation of the chronically ill patient cannot now be carried out efficiently except on the wards of a well-equipped hospital. This demands new methods and creates new problems in hospital organization and management.

The true democracy which we trust will emerge from the tragedy of World War II demands that the maximum in the care of the sick and injured be available for all, irrespective of their economic status. Such, as we all know and point to with pardonable pride, has been achieved for the fighting services of the Allies. In none has this been developed to a higher degree than in the medical organization of the American Forces. The public, which includes the veterans, will demand the same care and attention when sick or injured that they enjoyed in the combat services. This can be accomplished only by the greatest cooperation of all in the postwar scheme. We must seek the aid and tolerance, not only of each individual, but of each element in the country—the professions, industry, labor, and financial organizations. In the past it has been possible to set aside huge sums when any agricultural project seemed in jeopardy. One can well recall the readiness with which huge sums of public money were voted for the control of hog cholera and for foot and mouth disease in cattle; yet how difficult has it been to secure state aid for tuberculosis and cancer victims. Such individuals in the past have been cared for in great measure by the voluntary service of the profession carried out in institutions founded and maintained through the generosity of public-spirited individuals. The problems which confront governments and individuals are now, however, of such proportions that we can no longer expect private philanthropy to carry the burden of the group economically less fortunate. The necessary taxation resulting from the demands of war is rapidly placing all individuals in the same economic category. It becomes obvious that there must be some scheme which will provide and make available adequate medical care for all. Whether this comes from some state-controlled medicine or from some health insurance scheme does not at the moment alter the fact that financial help for the sick individual will be necessary. The solution of this problem of caring adequately for the sick will be sought by committees, from which we trust doctors will not be excluded. The scheme ultimately evolved will undoubtedly have far-reaching results for our profession. Such results may be disastrous if we all assume an indifferent or detached attitude, or if we fail to recognize and accept our responsibility as individuals. One can, without much difficulty at the moment, visualize a situation where

the majority of our profession may feel that as individuals they are completely impotent to alter or control the trend in medical practice, or modify a way of life. They may conclude that it is not their individual responsibility, that it is the responsibility of this or that committee, or even of governments, without defining for themselves what they mean by government. Let us remind ourselves that in this recent conflict, despite the highly mechanized armies which the Allies put in the field, no major gains were made or achieved without the infantry. We realize that no infantry unit is greater than the initiative and courage of the individual soldier; hence, no government can be efficient without initiative and courage in the individuals who make up the government. One hears individuals offering criticism freely. This is the privilege of all democracies. However, as is usual with most privileges, there is a penalty. In this instance such criticism must not only be accurate and constructive, but must be implemented by adequate action. No government group or committee struggling for a solution of this difficult problem of adequate medical care can arrive at the optimum conclusions except with the help and thought of all concerned. One is happy in believing that the vast majority of our profession attempt, to the best of their ability, to discharge their responsibility as individuals and to maintain the high standards of our predecessors. We must not lose sight of the fact that never has a problem in human relations been solved adequately by dictators or man-made laws. The solution of such problems will arise from a desire to practice the golden rule, which must lie deep in the heart of the individual. Let us remember that the final decision results from the correlation of the multitudinous individual contributions. We must associate ourselves with that "group of men who believe that the world is not finished: who realize that nothing is constant but change. We must work day after day, not to finish things, but to make the future better, because we will spend the rest of our lives there." Let us therefore take courage from the great work and industry of individuals who have contributed so much to the advancement of our professional usefulness. Let us all make our contribution, no matter how small. We can recall many occasions when the value of a contribution was not realized or appreciated until long after it was made. When Fleming noticed an absence of the colonies of staphylococcus surrounding the mold on his culture medium in 1929, he could not possibly have envisioned the tremendous contribution which penicillin is now making in the control of infection. It is true that many investigators have contributed to the ultimate application of penicillin to the clinical problem. It was, nevertheless, the astute observation of the individual which made possible the final magnificent result. If each of us, by emulating those of our profession who have made great contributions, will do his utmost to aid in the solution of the problems at hand, we shall do much to secure adequate care for the sick and injured, and to maintain harmony in social relations which will reflect the highest traditions of our profession.

"This above all, to thine own self be true, and it doth follow as the night the day, thou can'st not then be false to any man."

MASSIVE ORGANIZING HEMOTHORAX

Operative Treatment, Its Technique, Indications, and Pitfalls

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HEMOTHORAX as seen in war surgery differs from that of civil practice in several important respects. It is usually far larger in extent, often occupying most of a pleural cavity and greatly compressing a lung. Injury to the bony thorax may be much more severe, with extensive comminution of ribs, portions of which may be driven deeply into the lung substance. Damage to the lung parenchyma by whirling shell fragments is correspondingly greater and, perhaps because of the attendant release of quantities of thromboplastic substance, there is frequently coagulation of the blood with pocketing into large or small locules encompassed by strands and sheets of fibrin. This honeycomb or spongelike structure gradually undergoes organization, especially in thick layers over the visceral and parietal pleurae, and the underlying lung, collapsed in whole or in part, undergoes interstitial fibrosis which finally is irreversible.

The results of such a fibrothorax for the patient are dyspnea on exertion, permanent diminution of vital capacity, pleural pain, and occasional thoracic deformity with scoliosis—in short a life of semi-invalidism. Experience has shown that organizing hemothorax of the massive type does not clear up spontaneously regardless of the length of time it is allowed to persist.

In order to prevent these unfortunate end results, Nicholson and Scadding,[1] Churchill,[2] and others[3] during the war adopted the practice of open thoracotomy, and evacuation of the clots, with decortication and rapid re-expansion of the collapsed lung. The purpose of this paper is to describe the technical procedure and details which we have found valuable in accomplishing these ends in a general hospital overseas. We shall not here discuss the treatment of obviously infected organizing hemothorax.

The number of initial hemothoraces which will go on to organization is not large, somewhere about 10 per cent when prompt and repeated aspiration of unclotted blood is carried out, but a number do reach evacuation and general hospitals, often in an advanced stage. It was formerly taught that clotting of a hemothorax was due to the presence of infection; the cavities successfully closed by us and by others[2, 4] show that this is by no means the general rule.

Indications for Operation.—When massive hemothorax is known to be present and aspiration fails to obtain frank blood or obtains only a few cubic centimeters of thick dark blood or of serum, one may conclude that clotting and loculation have occurred. It is advisable to use a large caliber needle and to aspirate at least two points. X-ray examination usually shows massive clouding of one-half to all of one pleural cavity, often with pronounced mediastinal shift, and small levels of fluid may be observed in several loculi. Little or no

Presented at the Third Annual Meeting of the Central Surgical Association, Chicago, Ill., Feb. 22-23, 1946.

improvement can be seen in successive roentgenograms. Organizing accumulations involving more than 50 per cent of the pleural space are best treated by thoracotomy; those involving a lesser area generally recover as well by conservative measures.

Although currently advocated that decision for operation must be reserved for the third to sixth week after wounding, I have found that true organizing hemothorax of the massive type seldom clears spontaneously after it has once occurred, and meanwhile irreversible changes are taking place within the lung.

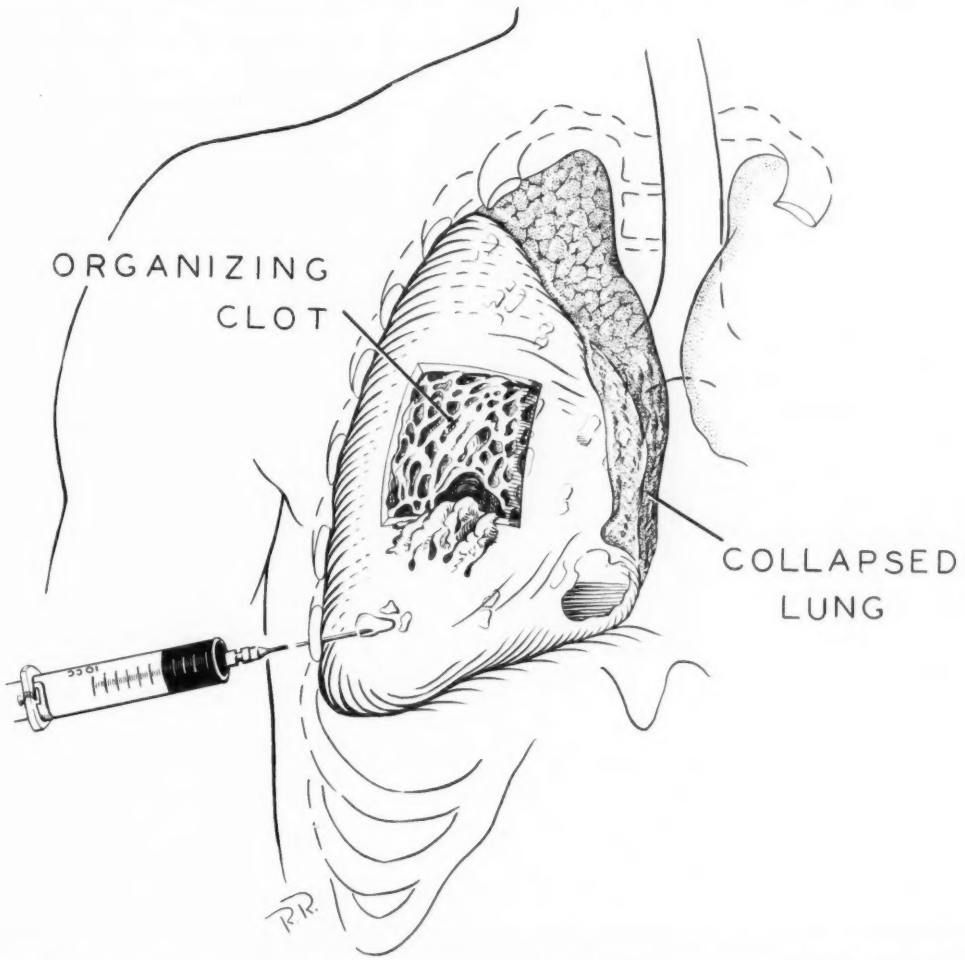

Fig. 1.—Artist's concept of a window cut in the thick parietal cortex exposing the character of the clots. The syringe below illustrates the very small amount of blood which can be aspirated.

Therefore, I operate as soon as the diagnostic criteria mentioned previously have been met. A few of Churchill's patients were operated upon as early as the sixth day after wounding; such early cases were among my best results. None of these patients, however, were operated upon before the eighth day. Unfortunately, the patients with the most extensive and morbid cases are too ill for transportation during this early opportune period and only reach the hospital

after the progression toward fibrothorax is well advanced. This was perhaps due to difficult terrain which delayed evacuation and transportation in the Philippine campaigns.

Anesthesia.—Intratracheal ether and oxygen have proved satisfactory, although if cyclopropane were available it would have been used. Pharyngeal packing with gauze is often necessary in order to insure an airtight system,

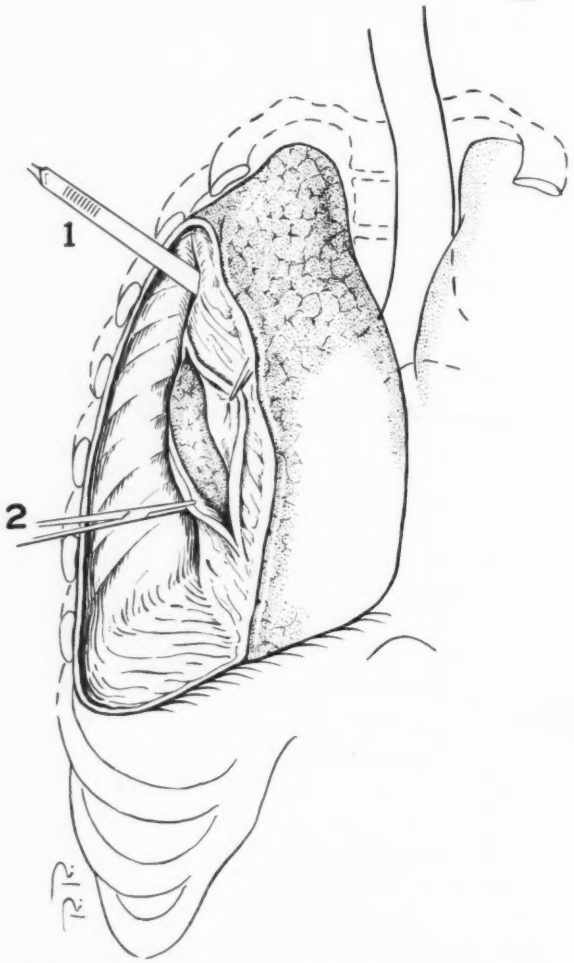

Fig. 2.—(*1*) A line of cleavage has been found posteriorly; (*2*) the visceral cortex is being peeled away and the lung released from its imprisonment.

particularly when intratracheal tubes without inflatable collars are used. Positive pressure is used although the danger of mediastinal shift during operation is remote except in very fresh cases because of the cementing action of the fibrin deposits.

Operative Procedure.—A posterolateral incision long enough to admit the operator's hand is made. On the left side a segment of seventh rib is resected; on the right side, a segment of the sixth. The massive clots are removed by hand and by suction, the various loculi broken down, the heavy strands of fibrin

trimmed away with scissors, care being taken to disturb no adhesions which might maintain expansion of the lung, and finally the cavity is washed out with warm normal saline solution. A varying amount of decortication, as will be discussed, is then carried out. The liberated lung is inflated as completely as possible under positive pressure just before the pleural cavity is closed. A large mushroom catheter is placed in the posterior axillary line, usually an interspace below the thoracotomy, and a smaller one in the second interspace anteriorly. The former provides drainage and the latter provides for the evacuation of trapped air. Penicillin, 100,000 units, in 100 c.c. of normal saline solution is washed into all recesses of the cavity, left in place, and the wound closed in layers. A bronchoscope is passed before the patient is removed from the operating table.

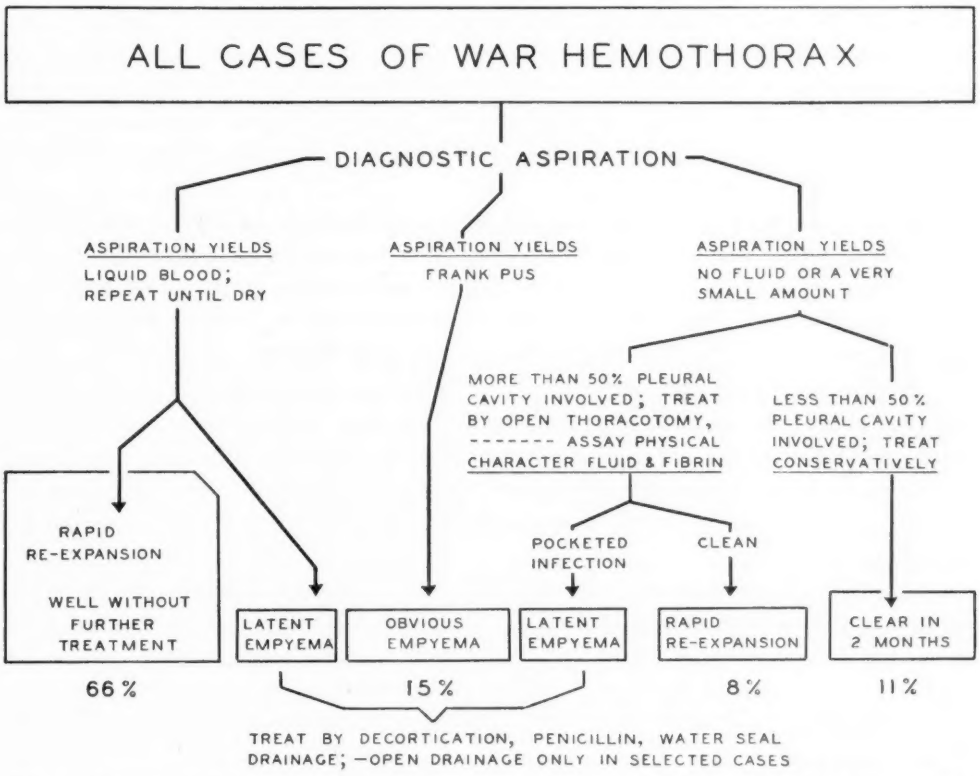

Fig. 3.—Treatment for various types of hemothorax. The group here discussed is represented by the clean 8 per cent.

Postoperative Care.—Both catheters are connected to sterile rubber tubes (plasma tubing is too small), the lower ends of which are placed beneath the surface of a sterile water bottle on the floor. The anterior catheter is removed after two days, the posterior one after about five days.

Penicillin is given intramuscularly for three days and instilled through the tube daily until its removal. Deep-breathing exercises and the use of blow bottles are encouraged. The patients are usually out of bed at the end of one week and have remarkably smooth postoperative courses. Most remarkable is

their great increase in vital capacity within a few days. I have had no deaths and no serious complications.

Rib Resection.—I now resect a rib in every case for the following reasons:

1. Wider exposure and inspection of the pleural cavity are allowed through a shorter linear incision than when no rib is removed.

2. Airtight closure of the chest wall is made easier by the approximation of two adjoining bundles of intercostal musculature.

3. Postoperative pain and discomfort are lessened.

4. Encircling pericostal sutures which frequently cut off the blood supply to the ribs are avoided.

Character of the Pleural Contents.—Bacteriologic reports on aspirated fluid are notoriously misleading regarding contamination or potential infection of the entire pleural cavity. This is because infection frequently remains sequestered in only one or a few small locules. This has been demonstrated by taking successive cultures from various locules at the time of operation, and finding all but one sterile. Portions of the visceral cortex, when ground up and cultured, show a high percentage of pathogenic organisms although the contained blood clot is sterile.

Pathogenic organisms may also lie latent within balls or masses of fibrin in the pleural cavity; accordingly, these should be removed with care and minimal trauma to prevent bacterial release. When such balls are crushed and cultured, a variety of staphylococci and streptococci can be demonstrated on the culture plate although the remainder of the pleural content proves sterile.

Solid clot, thick strong adhesions, thick chocolate-brown or black blood, the presence of clear serum or of thickened oleaginous fluid all speak for sterility. Soft or shaggy fibrin, its easy disintegration on pressure between thumb and finger, and a tendency toward hemolysis or a lavender hue—these are all danger signals and indicate to the surgeon latent or low-grade infection at the time of operation.

Decortication.—Once the clotted material has been evacuated the question of advisability of decortication arises. Shall it be attempted at all? If so, how much shall be carried out? It has been found that those patients coming to operation from one to three weeks after injury lend themselves readily to complete and effective decortication. The imprisoning fibrin layer peels away with relative ease, revealing the smooth salmon-pink and soot-speckled visceral surface; little bleeding is encountered and the lung readily expands under positive pressure.

When the condition has persisted for more than three weeks, decortication becomes progressively more difficult. The fibrin layer overlying the lung is much thicker; it has become organized into tenacious fibrous laminae resembling shoe leather, and has become densely adherent to the underlying visceral pleura. Attempts to remove such tissue frequently result in tearing into the lung parenchyma with the risk of pleural soiling and the production of diffuse bleeding. In these cases it is usually possible to find a cleavage line along the diaphragmatic surface of the lung and posteriorly in the vertebral gutter. In

these regions the visceral and parietal surfaces, having been in close apposition from an early stage and less subject to the process of organization which has operated on the lateral surface of the lung, are easily separated and a measure of re-expansion allowed.

In these late cases, however, interstitial fibrosis within the lung prevents immediate full re-expansion, a further reason for early operation. During decortication the removal of a fibrin seal may reopen an old bronchopleural fistula. Every effort should be made to avoid this and should it occur, the opening must be closed with mattress sutures of chromic catgut. During decortication on the right side one must beware of the thin-walled azygos vein. Decortication of the parietal pleura serves no useful purpose and may excite further bleeding.

The object of decortication is complete re-expansion of the lung and while the patient remains in good condition and there is little bleeding from the freed surfaces, one should not cease his efforts to remove the investment completely and gain maximal inflation.

Postoperative Drainage.—The early clean cases were closed without drainage, relying upon postoperative needle aspiration. Increasing experience has led to the use of catheter drainage with an underwater seal for a few days in every case. Postoperative accumulations of blood tend to clot readily; needle aspiration is quite ineffectual but these clots can be removed by irrigation through a tube.

Late Onset of Sepsis.—Surgeons have carried out evacuation of clot and decortication only to have the entire cavity develop suppuration a few days after operation. Although this may represent operative infection it is usually due to improper selection of cases for early catheter removal and disregard for the gross pathologic criteria mentioned previously which signal latent empyema.

In the several cases of this type we have found neither intrapleural nor intramuscular penicillin of much value; although the operative wound heals perfectly, the pleural process runs much its old-fashioned course, perhaps because of the presence of gram-negative bacilli. The treatment of polymicrobic war empyema, however, will be treated in a subsequent paper.

Immediate Results.—In this series thirty-eight thoracotomies were done. Thirty cases healed promptly with rapid re-expansion of the lung. The remaining eight patients developed infection which resulted in delayed expansion and empyema requiring evacuation to the United States.

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FURTHER EXPERIENCES IN THE SURGICAL TREATMENT OF CONGENITAL ATRESIA OF THE ESOPHAGUS WITH TRACHEOESOPHAGEAL FISTULA

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IN TWO previous communications,[1, 2] reports were presented concerning the surgical treatment of four infants born with atresia of the esophagus and tracheoesophageal fistula. Three were well, but the first child, who had had the correction carried out by the indirect multiple-stage method, was still undergoing plastic procedures on the antethoracic esophagus. The other two who were alive and well had had a direct anastomosis, while the fourth had died following an unsuccessful operation, because of a very short upper segment.

At this time, a statement will be made regarding the present condition of the first three patients and three new cases will be reported. The antethoracic esophagus in one infant (Case 1) has been completed and at the age of 2½ years, the child is eating without difficulty. Two infants (Cases 2 and 3) are alive and well at the ages of 16 and 15 months. All of the seven infants in this series had the Type 3(b) anomaly of the classification of Vogt,[3] with an upper blind pouch and a fistulous connection between the lower segment and the trachea (Fig. 1).

Although the procedure used in Case 1 is now thought to be inferior to the method of direct anastomosis, the case summary is presented because it illustrates the possibilities of an alternative method.

CASE REPORTS

CASE 1.—T. R., a boy, was born at the Henry Ford Hospital on Aug. 1, 1943. The diagnosis was established on the third day. Because of the high mortality then associated with the direct attack, the multiple-stage procedure was chosen. On August 4, under drop-ether anesthesia, the stomach was transected as near the cardiac orifice as possible, and mushroom catheters were placed in the two parts of the stomach. The proximal one was used to drain the remaining lower segment of the esophagus, and the distal one was used for immediate feeding. On August 18, the upper segment was exposed in the neck, and the lower end was exteriorized at a point just below the clavicle on the left. It was opened to permit the escape of saliva. On August 30 he was discharged, with the idea that he would be admitted to the hospital one year later for the construction of a skin tube to connect the cervical esophagostomy with the stomach.

He was readmitted on Jan. 21, 1944, because he had coughed up some material from a feeding, and it was obvious that a fistula had formed between the two parts of the stomach. On January 24, I ligated the lower esophageal segment close to the trachea, and transplanted the end of the esophagus to the lateral abdominal wall. On February 11, both gastrostomies were closed and the continuity of the stomach was re-established. Feeding was carried out by the intermittent insertion of a catheter into the abdominal esophagostomy. He was discharged on February 19 to await the final plastic procedures. He was admitted on Aug. 14, 1944, and on August 19 the end of the abdominal esophagostomy was transferred from the lateral abdominal wall to a point in the midline of the thorax as high as possible. Plastic procedures to construct the antethoracic esophagus

Presented at the Third Annual Meeting of the Central Surgical Association, Chicago, Ill., Feb. 22-23, 1946.

were then begun. A number of disappointments followed. These were due chiefly to attempts to take short cuts, utilizing dermatome grafts instead of full-thickness grafts to cover the raw surface of the skin tube which, of course, was constructed of full-thickness skin. Suffice it to say, after two attempts, one large and one small defect still remained (Fig. 2). From that time on, tubed pedicles were utilized to cover the cutaneous defects

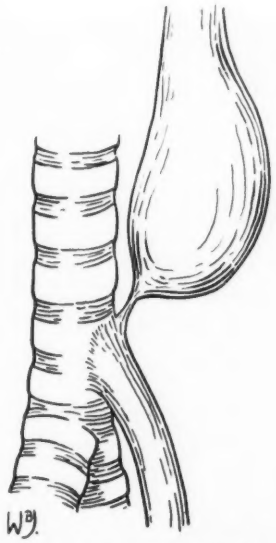

Fig. 1.—Diagram of the type of atresia with tracheoesophageal fistula encountered in all of the seven cases in this series—Type 3 (b) of Vogt.

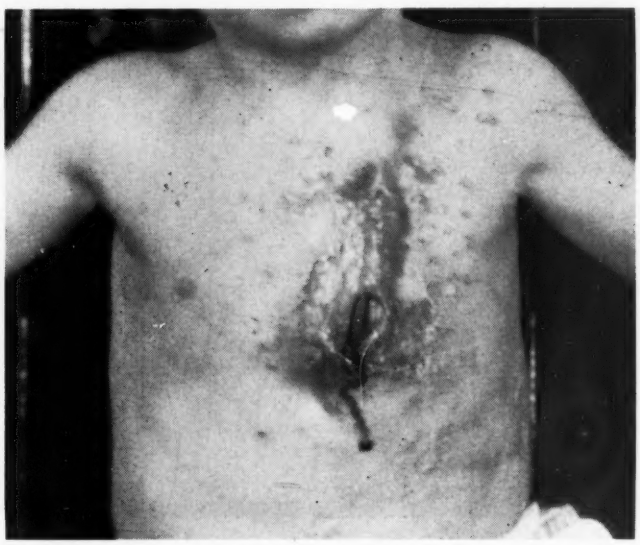

Fig. 2. (Case 1).—Photograph taken about Feb. 1, 1945, showing the situation after two attempts to complete the antethoracic tube. A large and a small defect remain; a rubber tube is temporarily inserted across the former.

(Fig. 3). Before final closure was obtained, there was trouble with a stricture at the junction of the skin tube and the lower segment of the esophagus. This was treated with an operative procedure and several dilatations with common bile duct dilators (up to No. 9). The last of twenty trips to the operating room was on Nov. 16, 1945. There has been no leakage since then and the child eats in a normal manner (Fig. 4).

The only other completed antethoracic esophagus for this condition reported in the literature is that described by Ladd,[4] although there is information about twenty-one children who survived the primary operations.[1, 5] Thirty-nine did not survive. Also, it is my understanding that the patient reported upon by Stoecklein and Nettrour[6] died of a late complication.

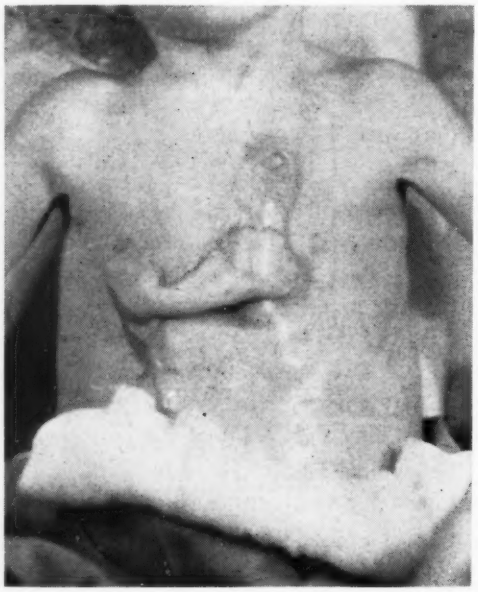

Fig. 3 (Case 1).—Use of tubed pedicle from abdomen to close the lower defect in skin tube.

Fig. 4 (Case 1).—The antethoracic tube has been completed and the child takes feedings easily.

My fifth case will be reported briefly, because it represents the result which may be obtained from direct anastomosis in the mediastinum according to the method described by Haight[7] and others.[1]

Case 5.—S. T., a colored female infant, was born in the Henry Ford Hospital on April 28, 1945. The diagnosis was established on the first day of life, and operation was performed the next day. A right-sided approach was used. No particular difficulties were

encountered during the operation. However, on the sixth day, there was leakage of formula from the drainage site in the back, and on the tenth day a gastrostomy for feeding was established. In spite of a mild attack of bullous dermatitis, the child made satisfactory progress and within one month the drainage from the back ceased, feedings by mouth were resumed, and the gastrostomy was allowed to close (Fig. 5). This child was in a normal state of nutrition at the age of 10 months.

The last two cases of the series are of particular interest because of the technical failures which occurred. In one instance, the death of the infant ensued and in the other, the procedure of direct anastomosis had to be abandoned in favor of the multiple-stage method.

Fig. 5 (Case 5).—Photograph showing the healed surgical incision.

CASE 6.—R. S., a boy, was admitted to the James Whitcomb Riley Hospital, Indianapolis, Ind., on June 9, 1945, at which time he was 5 days old. He had a history typical of atresia of the esophagus. Roentgenograms taken previous to admission showed a small quantity of air in the intestinal tract, while later views did not indicate this so clearly. The instillation of a small amount of lipiodol in the esophagus disclosed a large blind pouch at about the level of the fourth thoracic vertebra. I operated on this patient on June 10. The lesion was approached from the right. Some difficulty was encountered in locating the distal segment. However, when it was finally found and ligated, it was noted that it had the usual lumen, a fact which was surprising in view of the relative lack of air in the gastrointestinal tract as shown by roentgen examination. A satisfactory end-to-end anastomosis was carried out. When an attempt was made to withdraw the catheter over which the anastomosis had been made, some resistance was encountered. It was suggested that one or more of the sutures might have been inadvertently placed into the substance of the catheter. However, the catheter was removed with slight urging, and it was thought that the anastomosis had not been disturbed.

On the fifth day, the wound was dressed and it was found that there was considerable mucus on the dressing. Lipiodol given by mouth left the esophagus at the site of the anastomosis and passed out along the drainage tract. Gastrostomy was performed on June 18 by another surgeon. The condition of the child was fair until the fourteenth day, when the temperature suddenly rose from 99° F. in the morning to 106° F. in the late evening, at which time he died.

The autopsy showed the cause of death. The esophageal anastomosis was intact along its medial aspect, but laterally it had pulled open with sutures free in the wound. There was a pocket about this opening which was lined with granulation tissue draining to the outside through a fistulous tract. At the junction of the middle and lower thirds of the trachea, there was a round opening. There was no evidence of suture material in this region and it was thought by the pathologist that this opening corresponded to the original communication of the trachea with the distal segment of the esophagus as no other evidence of the amputated stump of the distal esophagus was found. It was noted that the cavity surrounding the esophageal anastomosis also included the opening into the trachea. In effect, the patient still had a tracheoesophageal fistula. Widespread pneumonia was present.

The patient probably would have survived with temporary leakage of the anastomosis or opening of the ligated tracheal fistula alone, but the presence of both was incompatible with life. One wonders if the forcible removal of the catheter at the end of the operation had compromised the anastomosis to favor the subsequent leakage. In the future, I shall remove the catheter while the site of anastomosis is visible. It must be concluded that the sloughing of the stump of the esophagus on the trachea with resulting re-formation of the fistula was due to tying the ligature too tightly.

Fig. 6 (Case 7).—A catheter has been inserted into the thoracic esophagostomy for feeding; the cervical esophagostomy is at the lower angle of the healed incision which parallels the sternomastoid muscle. Note the absence of irritation of the skin of the abdominal wall.

CASE 7.—E. L., a boy, was born in another hospital on Dec. 8, 1945. He was admitted to the Henry Ford Hospital on December 11, with the typical history and roentgen findings of atresia of the esophagus and fistula. He appeared to have sufficient length of segments, both by x-ray and at operation. For no particular reason, I approached the lesion from the left side and found that the aorta was troublesome, since the arch persisted in slipping in the way. This experience led me to resolve to make use of the right-sided approach in the future. Local anesthesia was being used as usual and the respiratory movements seemed especially violent. After the fistula had been ligated but before the lower segment had been cut loose from the trachea, a traction suture was placed. The opening in the upper pouch was made and the first posterior horizontal mattress suture was being placed. A vigorous inspiratory movement pulled out the traction suture and allowed the lower segment to disappear into the mediastinum. When it was recovered, the end was

frayed to such an extent that some length was lost, and further attempts at completing the anastomosis were futile. I believe that this part of the operation could be made immensely easier if the infant were receiving general anesthesia through an intratracheal tube, the so-called controlled respiration method. To dampen the enthusiasm for this suggestion, there is the report of Cassels and Yeager,[8] in which is described extreme damage to the vocal cords after a three-hour operation. Continuous intubation was necessary from the third postoperative hour until death, fifty-six hours after operation. The tube was inserted twelve times. It is not unlikely that with better luck, one careful intubation might suffice to provide the desired anesthesia with a quiet mediastinum and diaphragm during the tedious anastomosis.

Having abandoned further efforts to complete the anastomosis, it was decided to continue with the multiple-stage procedure rather than to allow the infant to die. Two days after the exploration and ligation of the fistula, a transverse incision was made beneath the left costal margin and after section of the short gastric and left gastric vessels, the lower segment was drawn out of the esophageal hiatus of the diaphragm and brought out through a subcutaneous tunnel to a point in the midline of the chest above the xiphoid process. Two days later, the upper pouch was brought out through the neck to a point below the clavicle (Fig. 6). This method of using a lower esophagostomy instead of a gastrostomy has several advantages. A catheter can be passed into the stomach intermittently for feeding. There is no escape of gastric juices to cause irritation of the skin. It is probable that when the antethoracic skin tube is constructed, it can be connected to the esophagus with its squamous epithelium easier than to the mucous membrane of the stomach. It will be noted that these three operative procedures over a period of one week accomplished the same anatomic result that five operations over a period of one year did in another infant (Case 1). It is planned to proceed with the plastic procedures in this patient at an early date.

SUMMARY

Seven infants with atresia of the esophagus with tracheoesophageal fistula have been operated upon, and five are alive. Three had the preferred operation of direct anastomosis. An alternative multiple-stage method was used in two of the surviving infants, and in one of these the surgical procedures are finished. Two infants have died, one following an unsuccessful attempt to perform the anastomosis, the chief difficulty being a very short upper segment. One infant died two weeks after a direct anastomosis with a recurrence of the tracheoesophageal fistula.

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POSTOPERATIVE PULMONARY EMBOLISM

A Review of Cases From 1939 to 1944

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POSTOPERATIVE pulmonary embolism is an all too frequent and unexpected tragedy. This paper reviews the cases of this kind which occurred in St. Mary's and St. Luke's Hospitals, Duluth, Minn., through the years 1939 to 1944, and is, in part, a continuation of a similar statistical report made by Graves[1] in the years 1929 to 1938 inclusive. In this study there were seventy-three cases of pulmonary embolism occurring after surgery or after trauma, an incidence of .134 per cent (Table I). Death occurred in fifty-one of these seventy-three cases and forty-two came to autopsy. It is significant that in only fourteen cases where emboli had been demonstrated at autopsy had embolism been suspected clinically. Autopsy also revealed that the most common source of the emboli was thrombosis of the femoral veins.

The most frequently reported clinical symptom in this series was pain in the chest. Thirty-three patients complained of pain, and, as a result, many cases were diagnosed as pleurisy.

The time between the onset of symptoms and death is shown in Fig. 1. In twenty-one cases (41.2 per cent) death occurred within one hour after the onset of symptoms of embolism. In twelve cases (23 per cent) death occurred within twenty-four hours, and in only eight cases did the patients survive more than one day. There were ten cases in which it was not possible to ascertain accurately the time of onset of symptoms.

The occurrence of pulmonary embolism and its relationship to age is shown in Fig. 2. Embolism occurred most frequently in patients between 40 and 80 years of age, but the highest incidence was in the fifth decade.

The incidence of pulmonary embolism in various types of surgery is shown in Table II. Operations upon the lower abdomen, including gynecologic operations, head the list in frequency. Thirty-three, or nearly 50 per cent of the total number, were in this group. Among specific operative procedures cholecystectomy led with nine, herniorrhaphy was next with eight, and appendectomy was third with seven.

The etiology of pulmonary embolism is thrombosis. de Takats[2] stated that age, obesity, and certain types of operations, such as surgery of the lower abdomen, pelvis, and lower extremities, predispose to it. Homans[3] stated that the more silent the process the greater the danger of embolism. According to him, pulmonary emboli may come from a clot in a leg that even those most familiar with venous thrombosis would consider normal, and by contrast the great swollen leg of thrombophlebitis almost never causes emboli.

Presented at the Third Annual Meeting of the Central Surgical Association, Chicago, Ill., Feb. 22-23, 1946.

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TABLE I. ANALYSIS OF PULMONARY EMBOLISM CASES AT ST MARY'S AND ST. LUKE'S HOSPITALS, 1939 TO 1944

	CASES	PER CENT
Total admissions	100,926	
Surgical admissions	55,938	
Medical admissions	44,988	
Cases of pulmonary embolism		
All admissions	131	0.128
Surgical admissions	73	0.134
Medical admissions	58	0.129
Total deaths	3,219	
Total autopsies	2,151	76.66
Total pulmonary embolisms, clinical and autopsy	131	
Total emboli proved by autopsy	69	
Percentage of all deaths		2.79
Percentage of all autopsies		3.20
Proved clinically and autopsy	17	
Proved clinically but no autopsy	19	
Recovered	41	31.30
Died	90	

The clinical picture of a large pulmonary embolism is classic. The patient is apprehensive, dyspneic, cyanotic, and complains of marked chest pain. The pulse is rapid and the blood pressure is low. Patients exhibiting these classic symptoms usually die rapidly, and with these I am not at the moment so concerned, but rather with those in whom the symptoms and signs are minimal. They are the patients for whom something can be done. A mild pain in the chest is often due to a small, nonfatal embolism. A complaint of discomfort in the legs, associated with tenderness, should not be slighted, because it may be the forewarning of an approaching embolism.

A slight rise in temperature should not be overlooked, especially if it is associated with one of these symptoms. A small infarct will often cause a rise in temperature. Phlebothrombosis, although not an inflammatory process, may also be accompanied by a slight rise in temperature. Slight apprehension is also suggestive. On examination, dorsiflexion of the foot (Homan's sign) causing pain in the calf muscles, and tenderness along the course of the deep veins, are almost positive signs of thrombosis. In phlebitis the fever, pain, and tenderness are more marked. Edema may be present in both, but it is more marked in phlebitis.

There are two methods by which pulmonary embolism ordinarily may be prevented. The first method is purely prophylactic, being directed toward the prevention of thrombosis, and may be applied to all, or nearly all, operative cases. The second method consists of adequate treatment to those patients whose complaints suggest thrombophlebitis, phlebothrombosis, or a nonfatal embolism.

Ochsner[4] stated that the prevention of pulmonary embolism should be thought of preoperatively, as well as postoperatively. Before surgery he recommended:

1. Stabilization of the cardiovascular system
2. Compression bandages to the lower extremities in all patients forty-five years of age or older, thus preventing superficial stasis, and at the same time accelerating deep circulation

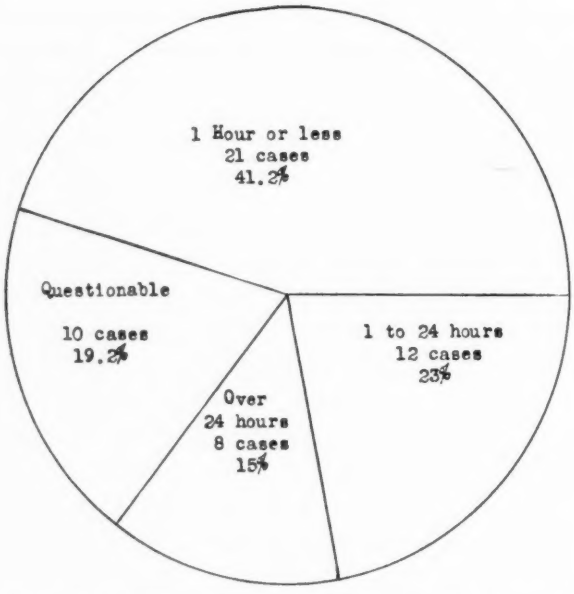

Fig. 1.—Time relationship between onset of symptoms and death.

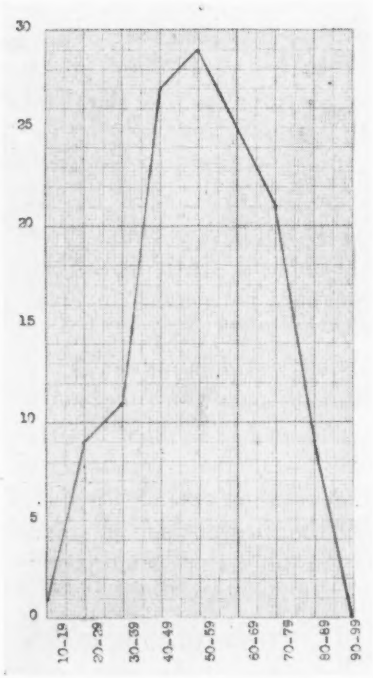

Fig. 2.—Age groups and pulmonary embolism.

TABLE II. SIXTY-NINE OPERATIONS PERFORMED ON SIXTY-SIX PATIENTS DEVELOPING EMBOLI

Head and Neck (1)	
Thyroidectomy	1
Upper Abdomen (15)	
Choledocholithotomy	1
Cholecystotomy and removal of stone	1
Cholecystectomy (including one case combined with herniorrhaphy)	9
Abdominal exploration for malignancy	4
Lower Abdomen (22)	
Laparotomy and drainage of abscess	1
Herniorrhaphy (including one patient with ligation of varicose veins, one with cholecystectomy)	8
Appendectomy	7
Bowel resection	3
Colectomy and colostomy	1
Abdominal-perineal resection of rectum	1
Hemorrhoidectomy (patient also had varicose vein ligation)	1
Gynecologic Operations (11)	
Hysterectomy	3
Parturition	1
Parturition and drainage of pleural cavity	1
Porro cesarean section	1
Salpingo-oophorectomy and hysterectomy	1
Salpingectomy (sutured ectopic)	1
Salpingo-oophorectomy	1
Hysteropexy	1
Dilatation and curettage	1
Urologic Operations (11)	
Exploration of kidney (patient also had fractures)	1
Suprapubic excision of bladder tumor	1
Drainage of perinephritic abscess	2
Suture of ruptured bladder	1
Nephrostomy and plastic	1
Prostatic resection	5
Operations on Extremities (9)	
Varicose vein ligations and injections (including one patient who had hemorrhoidectomy and one who had herniorrhaphy)	2
Open reductions	3
Reduction and fixation with Smith-Petersen nail	2
Removal of semilunar cartilage	1
Amputation of fingers and tendon repair	1

3. Hydration and remineralization
4. Correct anemia and plasma-protein levels
5. Finally, abstinence from smoking.

At surgery he recommended sharp dissection and no mass ligations. He suggested that cotton sutures be used because of less tissue reaction and that adequate fluids be administered during surgery. Postoperatively, he advised the use of the Trendelenburg position until the patient can freely move by himself, adequate postoperative fluid intake, exercises, deep breathing, and vasodilatation by the application of heat to the body.

As early as 1913, Pool[5] mentioned various exercises which were to be repeated throughout the postoperative period. He thought that they would decrease the convalescent period of the patient, in addition to avoiding an occurrence of

thrombosis. Gray[6] reported a decreased incidence of all pulmonary complications by using the Trendelenburg position.

In dealing with those patients who exhibit signs of thrombosis, thrombophlebitis, or nonfatal embolism, it is imperative that the treatment in these cases be carried out promptly.

At post-mortem examination small emboli which appear to be inconsequential are often found to be the sole cause of death. de Takats and Jesser[7] believed that reflexes are set up which originate in the occluded pulmonary artery tree, causing bronchial constriction, vasoconstriction, and dilatation of the right ventricle. Therefore, in those patients exhibiting characteristic signs of emboli, they recommend the following treatment:

1. The patient is to be placed in a semisitting position.
2. Nasal oxygen should be started.
3. Atropine sulfate, gr. 1/75, to be given intravenously along with papaverine, gr. ½. The atropine and papaverine may be repeated three or four times during the first twenty-four hours.

de Takats does not recommend the use of morphine or adrenalin because they sensitize the vagus and facilitate reflex spasm.

The treatment of thrombosis and the subsequent treatment of emboli consists of the use of the anticoagulants, heparin and dicumarol, and the surgical procedures such as lumbar sympathetic block and vein ligation.

In treating thrombosis with the anticoagulants it is important that the manner and time of action of each of these drugs are known. According to the literature, both act on the prothrombin but not in the same manner. Heparin acts by inhibiting the change of prothrombin to thrombin. It, therefore, acts on the prothrombin present in the blood stream and does not interfere with the manufacture of prothrombin by the liver. Its action is prompt. Dicumarol does not act on the prothrombin present in the blood stream but suppresses its manufacture. Hence, its action is delayed, and, because of this, there is a lapse of two or three days before the prothrombin level is decreased to a desirable point.

It is evident, then, that heparin and dicumarol should be started simultaneously. According to Lam,[8] the usual course of heparin administration is eight to ten days. According to Barker and associates,[9] dicumarol is continued until the patient becomes ambulatory. In the use of both heparin and dicumarol, the administration in each case must be individualized. The danger is hemorrhage. If bleeding occurs, the best form of treatment is transfusion of fresh, whole blood, and, in addition, large doses of vitamin K. Barker concluded from his investigation that sufficient elevation of prothrombin time by the use of dicumarol is completely effective in the prevention of postoperative thrombosis and pulmonary embolism.

Since Homans[10] in 1934 recommended femoral vein ligation for the prevention of pulmonary embolism, this procedure has gained more and more popularity. Allen[11] and his associates, through Aug. 1, 1945, performed 861 femoral vein interruptions. They have gradually become convinced that bilateral inter-

ruption of the femoral vein distal to the profunda femoris should be performed. This operation, they state, is safe, simple, and if done on a normal vein produces little swelling of the extremities so that prophylactic vein interruptions are being done with greater frequency. They especially feel that older individuals may be more safely managed by prophylactic femoral vein ligation.

Ochsner subdivides thrombophlebitis into the suppurative and the nonsuppurative type. In treating the former he recommends ligation as early as possible. In the nonsuppurative type, he advises the use of the lumbar sympathetic block to relieve spasm and edema, as long as the patient has fever.

In recent years, our experience with heparin has been minimal while dicumarol has been used almost exclusively. Daughtry in his recent article accounted for the use of the latter drug in St. Mary's Hospital. A few femoral vein interruptions have been performed after the occurrence of a nonfatal embolism.

SUMMARY AND CONCLUSIONS

A study of postoperative embolism in St. Luke's and St. Mary's Hospitals between the years 1939 and 1944 is presented. The incidence of pulmonary embolism in this period was 0.128 per cent; the incidence among surgical patients was 0.134 per cent.

The most common source of embolism was thrombosis of the femoral veins.

Forty-one per cent of the patients developing pulmonary embolism died within one hour; 23 per cent died between one and twenty-four hours; 15 per cent died after twenty-four hours.

Most of the deaths occurred between the ages of 40 and 80 years, the greatest number between the ages of 50 and 60.

Embolism occurs most frequently following surgery upon the lower abdomen, including gynecologic operations. Among specific operative procedures, cholecystectomy leads with nine cases, herniorrhaphy with eight, and appendectomy with seven.

Early symptoms suggesting thrombosis are apprehension, increased pulse, slight fever, pain in the calf muscles on flexion of the foot or upon pinching the muscles, and tenderness along the course of the deep veins.

Prophylactic measures suggested by Ochsner to prevent thromboses should be routinely carried out. The importance of papaverine and atropine in large doses, at the onset of the attack, as suggested by de Takats, should be emphasized. When thromboses develop, the question of the administration of heparin or dicumarol should be considered.

Finally, the prophylaxis or the early interruption of the femoral veins should be more frequently undertaken.

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MANAGEMENT OF PULMONARY ABSCESS

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THE management of pulmonary abscess is still the subject of much controversy. In spite of the availability of chemotherapeutic and antibiotic agents, the widespread use of blood transfusion as a supportive measure, and the great technical improvements in surgical procedures, the mortality of pulmonary abscess remains high and the morbidity prolonged. It seems logical, therefore, that forms of therapy be studied and the results evaluated from time to time. It is with this in mind that we present the following review of our experiences of the past four years, 1942 to 1945, inclusive.

Seventy-one cases of pulmonary abscess have been studied, 54 from the medical and surgical services of the Cincinnati General Hospital, and 17 in consultation in other hospitals. The survey includes all patients with pulmonary abscess seen, exclusive of those in whom the diagnosis of tuberculosis was established. There were 54 males and 17 females; the age range was 4 to 90 years, with the highest incidence in the decade from 41 to 50. In 33 of the 71 patients the abscess developed following pneumonia. In 20 the cause was aspiration, such as occurs during diabetic coma, epileptic seizures, intraoral operations, or general anesthesia. In 5 the abscess followed pulmonary infarction. In 10 the pathogenesis was not clear. Of the remaining 3, one was associated with malignancy, one resulted from a penetrating gunshot wound of the chest, and the third followed occlusion of a bronchus by aneurysm of the aorta.

Fifty (70.5 per cent) of the abscesses occurred on the right side, 22 in the upper lobe, 4 in the middle lobe, and 17 in the lower lobe. In 7 patients more than one lobe was involved. Nineteen (26.7 per cent) of the abscesses occurred on the left side, 8 in the upper lobe and 7 in the lower, while in 4 patients both lobes were involved. In 2 instances the abscesses were bilateral.

It is noteworthy that this anatomic distribution did not vary significantly regardless of the pathogenesis of the abscess. Of the 33 abscesses following pneumonia, 25 (75.8 per cent) occurred on the right side and 8 (24.2 per cent) on the left. Of the 20 following aspiration, 15 (75 per cent) occurred on the right, 4 (20 per cent) on the left, and 1 (5 per cent) on both sides. Of the 5 associated with embolus, 3 (60 per cent) were right-sided and 2 (40 per cent) were left-sided. Of the remaining 13, 7 (53.8 per cent) were on the right, 5 (38.5 per cent) were on the left, and 1 (7.7 per cent) was bilateral.

Presented at the Third Annual Meeting of the Central Surgical Association, Chicago, Ill., Feb. 22-23, 1946.

This retrospective analysis has emphasized to us a deficiency in the study of these patients, namely, the lack of accurate bacteriologic data which we feel might have had considerable prognostic significance.

The therapy employed in the management of these 71 cases falls into two broad categories, nonsurgical and surgical. The former includes control of activity, supportive measures, the use of chemotherapy and antibiotics, and nonsurgical drainage. Ideally, control of activity means absolute bed rest. Supportive measures include a diet high in protein, carbohydrate, and caloric content with supplementary vitamins and iron; whole blood transfusions to combat anemia; and plasma or plasma substitutes to offset hypoproteinemia. Routine sulfonamide therapy was employed throughout the period of this survey and in the last two years penicillin has been universally available. Nonsurgical drainage was accomplished by transbronchoscopic aspiration and by active postural drainage. The surgical methods employed were transthoracic drainage and pulmonectomy, either partial or total.

The obvious point at which to obtain an initial gross estimate of the value of any therapeutic program is the total mortality. We were dismayed to find that in this series of 71 patients there were 30 deaths, a mortality of 42.3 per cent. Such a figure demands clarification. Investigation revealed that in 13 patients death was unequivocally due to diseases other than the pulmonary abscess, which was either terminal or of secondary importance. This group includes such entities as terminal cardiac failure, carcinomatosis, aneurysm of the aorta, and encephalitis. In all but two the diagnosis was made only at autopsy.

Elimination of these 13 patients leaves a group of 58 patients among whom there were 17 (29.3 per cent) with death attributable directly to pulmonary abscess or complications thereof. In 2 the disease followed a fulminating course to death within a few days after admission to the hospital despite all possible nonsurgical therapy. Death occurred in 2 others who refused to follow the therapy prescribed. There were 6 other deaths among patients for whom only nonsurgical measures were employed. In 2 the nature of the primary lesion was unrecognized; in the remaining 4, surgical intervention might have prevented the fatality. On the other hand, there were 7 fatalities among the 22 patients treated surgically. Two occurred after simple transthoracic drainage; one on the eleventh postoperative day of hemorrhage and the other three months postoperative as the result of hemorrhage from residual bronchiectasis, for which lobectomy had been planned. The last 5 deaths followed successful or attempted primary pulmonectomy. These deserve explanation.

1. Attempt at lobectomy was abandoned when massive intrapulmonary hemorrhage developed before the pleura was opened. The patient continued to hemorrhage and died three days later. He had a known abscess for eight months and had had repeated massive pulmonary hemorrhages for three months before surgical consultation was sought.

2. Death occurred from pneumonia on the third postoperative day following left lower lobectomy. The bronchial tree could not be kept free of mucus

despite repeated bronchoscopic aspiration and constant use of transnasal suction. He had had a known lung abscess for seven years, and in the two years preceding operation had been treated by transbronchoscopic aspiration twenty-five times before surgical assistance was requested. The abscess was centrally located and inaccessible to transthoracic drainage.

3. A 4-year-old child's right lung was completely destroyed by immense abscesses. He had been the victim of gross neglect for three years before surgical assistance was requested. Pneumonectomy was undertaken in a desperate effort to relieve the child. Death occurred during operation.

4. A patient had been treated by nonsurgical measures over a period of two years for multiple abscesses of the left lung until evidence of metastatic brain abscess developed. Neurologic signs receded and it was decided to treat the brain lesion expectantly. Pneumonectomy was successfully performed. One month later the patient developed a fulminating exacerbation of the cerebral abscess and died.

5. A 67-year-old woman had a pneumonectomy because of a mistaken diagnosis of bronchogenic carcinoma. Pathologic study of the excised lung revealed simple abscess. The immediate postoperative course was uneventful, and the patient was discharged from the hospital. Three weeks later she was brought back moribund. She had empyema of the residual dead space and a bronchopleural fistula with massive pneumonia of the opposite lung.

Of the 41 patients who survived, 26 received only nonsurgical therapy. Of these, 23 are apparently completely cured. Three passed out of our control before adequate treatment could be completed. The remaining 15 surviving patients, having failed to respond to a nonsurgical regime, were treated successfully by surgical intervention. In 10, transthoracic drainage was sufficient to produce complete cure. In 3, drainage alone was insufficient and a secondary pulmonary resection was employed successfully. In the last 2 patients primary pulmonary resection succeeded in eradicating the patient's disease; in one a left total pneumonectomy was done for multiple chronic abscesses; in the other a right lower lobectomy was used to excise a central abscess about a tooth, which had been aspirated during an extraction under general anesthesia.

CONCLUSIONS

A study of these 71 patients suggests the following conclusions. Twenty-three apparent cures in patients treated adequately by nonsurgical therapy alone demands that such conservative measures be given adequate trial. However, the death of 8 patients in whom only nonsurgical measures were employed, and of 5 patients for whom surgery was requested as a last desperate resort, indicates beyond doubt that nonsurgical therapy is frequently inadequate. Consequently, reasonable limits must be set, beyond which the inadequacy of nonsurgical methods is recognized and surgical treatment instituted.

With these lessons in mind we have formulated the following plan of management. All cases of suspected pulmonary abscess should be evaluated jointly by internist and surgeon. Unless special circumstances demand prompt

surgical intervention, all pulmonary abscesses deserve a trial on nonsurgical therapy. It must be stressed, however, that the nonsurgical measures previously outlined must be applied vigorously and persistently for a reasonable period of time, with frequent estimates of the patient's response. Furthermore, the limitations of such a conservative regime must be recognized and surgical treatment instituted before the patient suffers irreparable damage.

Our criteria for surgical intervention in the form of transthoracic drainage are the following:

1. Failure of the abscess to recede within six weeks
2. X-ray and clinical evidence of the process spreading at any time
3. Any prolonged interruption in the process of resolution of the abscess
4. Persistent or repeated small episodes of hemorrhage
5. The presence of a foreign body

Finally there is a group of conditions in which drainage alone is inadequate. For these, lobectomy or pneumonectomy is necessary. They are as follows:

1. Persistence of abscess in spite of adequate drainage
2. Multilocular abscesses in which adequate drainage is impossible
3. Abscesses so placed as to be inaccessible to simple drainage
4. Persistent bleeding
5. Residual bronchiectasis
6. Multiple abscesses
7. Any question of malignancy

SUMMARY

An analysis of 71 cases of pulmonary abscess encountered during the years 1942 to 1945, inclusive, has been presented, and a plan of management for these cases outlined.

ACUTE SECONDARY PAROTITIS

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ACUTE secondary parotitis is an uncommon but serious nonspecific infection of the salivary glands produced by pyogenic bacteria. Its incidence varies between 0.04 and 0.74 per cent[1, 2] of all patients subjected to major surgical operations, the average being somewhat less that 0.5 per cent[3] in collected series. It is important because of the high mortality rate of patients developing it. This frequently reaches 40 to 60 per cent[4] and is due principally to its tendency to occur in patients delibilitated[5] by prolonged illness, severe infections, serious metabolic disturbances, major operations, or extensive injuries.

Occasionally cases are hematogenous in origin, but most of them are undoubtedly the result of an ascending infection along Stensen's duct from a mouth which is dirty because of dehydration, suppression of salivary secretion, dental caries, and sustained mouth breathing producing dryness of the mucous membranes and the accumulation of sordes about the teeth, tongue, and oral mucous membrane.

Numerous forms of treatment have been developed for this condition based upon empiric results or anatomic and physiologic principles. Effective prophylaxis consists of the adequate treatment of the primary diseases, correction of the metabolic disturbances which predispose to its development, and the correction of the poor hygenic conditions[6] of the mouth which may precipitate it. The various forms of treatment developed for established acute secondary parotitis consist of the following kinds:

1. *Symptomatic.* Conservative management including general supportive therapy and the application of massive hot moist compresses to the involved area produced spontaneous resolution in many of the milder cases, but most of the more severe cases, however, showed remarkable tendency to progress to necrosis and abscess formation.

2. *Surgical.* The operative treatment consisted of either the incision and drainage of localized abscesses and areas of necrosis after they had developed[5] or an attempt to prevent or minimize the development of necrosis caused by increasing pressure within the dense fascial compartments[7, 8] by early incision and drainage.

3. *Radiotherapy.* Irradiation by the application of packs of filtered radium[2] or roentgen therapy[8] has been used successfully, and many who have used this form of treatment regard it as almost specific.[2]

4. *Dilatations.* Repeated dilatations of Stensen's duct was the form of therapy advocated by Hobbs and Sneierson;[9] it should be reserved for those cases manifesting some form of obstruction to the free flow of saliva.

Presented at the Third Annual Meeting of the Central Surgical Association, Chicago, Ill., Feb. 22-23, 1946.

5. *Chemotherapy.* Recently several chemotherapeutic agents have become available for use in this as well as other infections. The sulfonamides have been disappointing as a means of arresting the infection and causing spontaneous resolution. In 1935, Leithauser and Cantor[10] first reported the use of massive doses of Lugol's solution in ten cases of acute secondary parotitis without a death. They pointed out that iodine was promptly excreted by the parotid gland, and that it possessed a beneficial antiseptic effect in this infection. More recently, preliminary reports[3, 11-13] indicate that penicillin is effective in the control of secondary parotitis.

MATERIAL

During the past nine years, I have seen forty-nine patients with acute secondary parotitis, ten of whom were seen at the Henry Ford Hospital before June 1, 1940, and the remaining in and about Cincinnati thereafter. The average age of the group was 47.5 years, the youngest patient being 7 years old and the oldest, 84. Twenty-eight were 40 years of age or older, emphasizing its frequency in middle-aged or older adults. The infection was unilateral in the great majority of instances, involving the right side in twenty-five instances, the left in nineteen, and both in four. Its onset was considered to be sudden in thirty-one and more gradual in seventeen. All but two of the cases occurred in patients debilitated by some demonstrable and serious primary disease or injury shown in Table I.

One of the most obvious factors was poor oral hygiene. Dehydration, mouth breathing, suppression of salivary secretion, and dental caries favored the development of an ascending infection along Stensen's duct (Fig. 1).

Associated with the onset of this complication, a sharp elevation of body temperature, pulse rate, and white blood count usually occurred. The average

TABLE I. ACUTE SECONDARY PAROTITIS AND ASSOCIATED PRIMARY CONDITIONS

Metabolic	
	1. Dehydration with poor oral hygiene
	2. Suppression of salivary secretion
	3. Uremia
	4. Cirrhosis of liver
	5. Uncontrolled diabetes
	6. Generalized arteriosclerosis
	7. Obstructive jaundice
Septic	
	1. Septicemia
	2. Peritonitis (appendicitis, cholecystitis, etc.)
	3. Abscess (intra-abdominal, psoas)
	4. Urinary extravasation
	5. Carbuncle
	6. Infectious gangrene
	7. Meningitis
Neoplastic	
	1. Carcinoma
	2. Sarcoma
Traumatic	
	1. Fractures
	2. Extensive soft tissue injuries
Hemorrhagic	
	1. Gastrointestinal
	2. Genitourinary
	3. Cerebral

temperature on the day of onset was 101.9° F., the highest being 104.6 and the lowest 98.0. The average pulse rate was 114, and the extremes were 140 and 88. The highest white blood count was 28,000, the lowest being 4,050 and the average, 16,200.

The etiologic agents were determined in all but twelve cases by culturing the purulent material which was expressed from the orifice of the salivary duct or which was obtained by aspiration or incision and drainage of an abscess (Table II). The infection was monobacterial in twenty-three instances and polybacterial in fourteen.

Fig. 1.—*A*, Photograph illustrating the location, extent, and nature of the swelling. *B*, Showing the very poor hygiene of the mouth. Note the sordes and drop of pus escaping from orifice of Stensen's duct. Acute secondary parotitis of three days' duration.

METHOD

The systemic administration of large dosse of Lugol's solution as advocated by Leithauser and Cantor was used as the primary treatment in all but four of the cases. Three patients received penicillin therapy and the remaining two both Lugol's solution and penicillin. The general plan of treatment consisted in the administration of 120 to 250 minims of Lugol's solution per day at the earliest opportunity until definite improvement occurred. Thereafter, as further improvement occurred, the daily dose was progressively reduced. The greater part was given by mouth whenever possible, and smaller supplemental amounts were given by hypodermoclysis, intravenous infusion, or proctoclysis. A commonly used schedule consisted of the daily administration of 20 minims every

TABLE II. BACTERIAL ETIOLOGY OF ACUTE SECONDARY PAROTITIS

BACTERIUM	NUMBER OF CASES
Hemolytic Staphylococcus aureus	31
Nonhemolytic staphylococcus	4
Hemolytic streptococcus	4
Streptococcus viridans	2
Nonhemolytic streptococcus	5
Bacillus proteus	1
Unknown	12

three hours by mouth and 60 minims by hypodermoclysis along with 1,500 c.c. physiologic saline solution given to help correct the dehydration. When definite improvement occurred, the intramuscular dose was discontinued and the oral dose was decreased to 15 and later 10 minims every three hours until the process had completely subsided. The average duration of therapy with Lugol's solution was seven days, the longest being fourteen. The average total dose was 823.4 minims, the highest being 2,880 minims and the lowest 180 minims.

If a definite abscess was present before or at the start of treatment, it was carefully incised and drained. If an abscess developed during the treatment it was likewise incised and drained in all but two instances, when repeated aspirations were done.

Other supportive therapy included the use of massive hot compresses, general supportive measures, and the treatment indicated for the underlying primary disease.

In the five cases in which penicillin was used, it was used alone in three cases, and as a supplement or compliment to Lugol's solution in the other two. The dose employed was 15,000 units every three hours.

RESULTS

The results of Lugol's therapy in forty-six cases of secondary parotitis were impressive. In three cases the abscess, which had formed before the start of treatment, was incised and drained prior to or immediately after the start of Lugol's therapy. Thereafter the process subsided rapidly. The duration of the process in these three instances was seven, eighteen, and thirty days before the start of Lugol's therapy. In the remaining forty-three patients treated with large doses of Lugol's solution, complete spontaneous resolution occurred in twenty-nine cases or 67.4 per cent, and partial resolution with abscess formation occurred in five cases. Definite but incomplete resolution without abscess formation occurred in six cases when the patient died of the primary disease two to five days after the start of treatment.

An incision and drainage, which was carried out unnecessarily in one instance during treatment with Lugol's solution, failed to demonstrate an abscess. The remaining three patients failed to show any obvious response to this form of treatment.

When spontaneous resolution occurred, little or no evidence of improvement in the general or local signs of infection was present during the first thirty-six to forty-eight hours after the start of the treatment. Thereafter (Figs. 2 and 3),

the temperature, pulse rate, and white blood count usually fell rather sharply, reaching normal one to four days later, unless the primary disease continued to cause fever. At the same time, but more gradually, the local signs of infection receded. The swelling and induration began to recede, the pain decreased, and the bright red or cherry red discoloration of the overlying skin assumed a bluish red and later a pale slate-blue color. The results of treatment are illustrated in Table III.

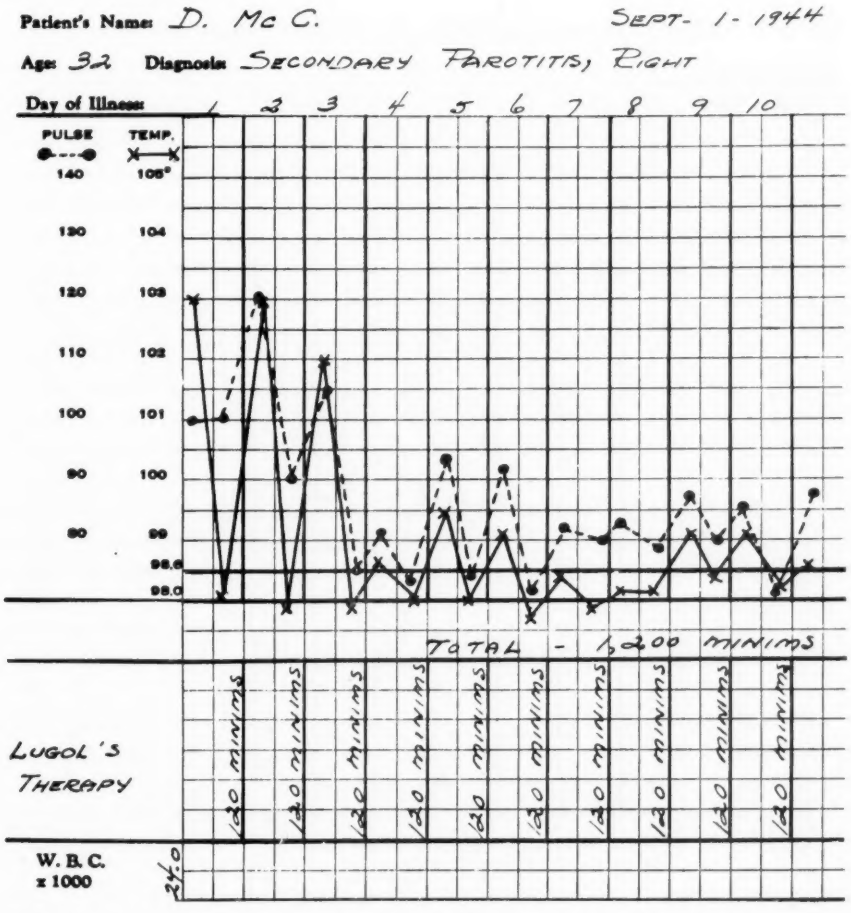

Fig. 2.—Chart illustrating a typical clinical response of acute secondary parotitis to Lugol's therapy when treatment is started within twenty-four hours of the onset of infection. Note lack of response in temperature and pulse rate for forty-eight hours, followed by rapid fall of both.

The results of treatment with penicillin were very encouraging. One patient who failed to respond to therapy with Lugol's solution responded satisfactorily to penicillin. Three others treated primarily with penicillin also underwent spontaneous resolution. A fifth underwent partial resolution with abscess formation.

Although fifteen of the forty-nine patients died, giving a mortality rate of 30.6 per cent, it was interesting to note that before or at the time of death,

complete resolution of the parotitis had occurred in seven cases, definite but incomplete resolution of the parotitis had occurred in six cases, abscess formation in one, and outright failure in one. Thus, in thirteen of the fifteen fatal cases the parotitis had completely or partially resolved without clinical evidence of abscess formation under chemotherapy before death occurred. The principal causes of death were found to be the underlying primary diseases (Table IV).

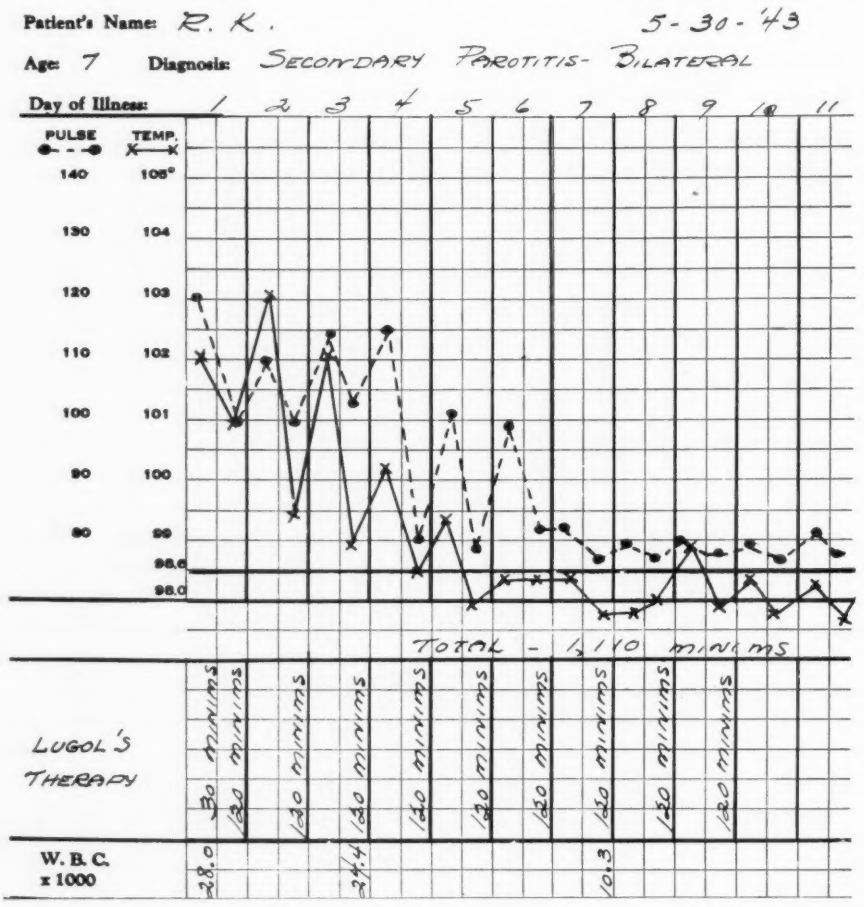

Fig. 3.—The results of adequate treatment with large doses of Lugol's solution are shown in a case of bilateral acute secondary parotitis. Note delay of forty-eight hours before start of response.

DISCUSSION

The control of acute secondary parotitis by chemotherapy is desirable since its arrest by conservative measures is uncertain and its control by surgical incision and drainage has certain disadvantages. Incision may result in unsightly scars, occasional injury to the facial nerve, salivary fistulas, or troublesome secondary infection. In addition, a general anesthetic and operation unquestionably throw an added burden upon the patient greatly weakened by some other primary disease. The simplicity of administration and the directness of action of effective chemotherapy largely obviate these disadvantages.

TABLE III. RESULTS OF TREATMENT OF ACUTE SECONDARY PAROTITIS WITH LUGOL'S SOLUTION

TREATMENT	NUMBER OF CASES
Complete spontaneous resolution	29
Partial resolution without abscess formation	6
Partial resolution with abscess formation	5
Failure	3
Total	43

NOTE: Three cases with abscess formation at start of treatment are not included in this table.

The general response of this infection to both Lugol's solution and penicillin therapy follows the general pattern seen in other surgical infection treated by chemotherapy. An interval of twenty-four to forty-eight hours following the start of treatment precedes the development of obvious signs of clinical improvement. Thereafter, the improvement is progressive and usually rapid.

The probable mode of action of Lugol's solution used in massive doses for the treatment of parotitis is twofold: bacteriostasis and stimulation of salivary secretion. It is well known that the iodine of Lugol's solution is readily absorbed by the blood from the various routes of administration and excreted by the salivary glands in the increased amounts of saliva. Swallowing of the saliva containing iodine permits its reabsorption from the enteric tract creating a cycle of iodine absorption and excretion. The concentration of iodine in the blood supplying the parotid gland and in the saliva following massive doses of Lugol's solution is believed to have a bacteriostatic effect upon the infecting bacteria. Stimulation of salivary secretion is a desirable effect in acute secondary parotitis since diminution or suppression of this function is commonly present.

Throughout the study there has been great concern with the possible danger of producing iodine poisoning with these large doses, but fortunately we have seen no evidence of it. The possibility should be kept constantly in mind, however, by anyone who uses this form of therapy.

Although the number of patients treated with penicillin is very small, there are definite indications that it is very effective in the control of this infection. The pyogenic bacteria causing it are sensitive to the action of penicillin in the great majority of instances. In one case penicillin cleared up the parotitis after Lugol's solution failed to alter the course of the infection.

An analysis of the causes of death in acute secondary parotitis emphasizes the fact that this disease is usually superimposed upon a serious primary disease. For this reason, it seems likely that there will always be an appreciable mortality

TABLE IV. CAUSES OF DEATH AFTER ACUTE SECONDARY PAROTITIS

DISEASE	NUMBER OF CASES
Arteriosclerotic heart disease with terminal failure	2
Extensive hemorrhage	3
Septicemia	2
Uremia	2
Generalized peritonitis	2
Far-advanced carcinoma	1
Cerebral thrombosis	1
Pneumonia	1
Undetermined	1

rate associated with it until more effective treatment is developed for the primary diseases.

In addition to general supportive therapy and the indicated treatment for the primary diseases, successful management of acute secondary parotitis by chemotherapy depends upon the following definite principles:

1. *Early diagnosis.* Early diagnosis permits early and specific treatment of the infection by chemical agents while it is in the diffuse stage before necrosis or the formation of abscesses has occurred. Cases of parotitis treated within twenty-four hours of onset gave the best results with complete and spontaneous resolution.

2. *Adequate and continuous chemotherapy.* In addition to the early use of penicillin or Lugol's solution, their administration must be carried out in large enough doses to insure effective levels in the blood and parotid gland, and at long enough intervals to permit complete resolution. Interrupted chemotherapy is to be discouraged because of the danger of producing increased resistance of the infecting bacteria.

3. *Intimate contact of the chemotherapeutic agent with bacteria.* The chemotherapeutic agent must reach all of the infected tissues in sufficient concentration to inhibit the growth of or destroy the infecting bacteria without harmful effect upon the host. This is readily possible during the early and diffuse stage of the infection but may not be later because of the impairment of the blood supply, necrosis, or development of abscesses. For this reason, an abscess developing before or during treatment should be incised and drained to liberate the pus containing viable bacteria and their necrotizing toxins. Foreign bodies such as salivary calculi will likewise prevent complete response to chemotherapy until they are removed.

SUMMARY AND CONCLUSIONS

A study which has been made of the etiology, nature, and treatment of forty-nine cases of acute secondary parotitis indicates that modern chemotherapy is a very effective and simple method of control of this infection. Early and adequate treatment with massive doses of Lugol's solution was found to give very satisfactory results and penicillin therapy in a small number of cases showed much promise. One patient who failed to respond to Lugol's therapy responded to penicillin. Spontaneous resolution occurred in all but one of the early cases with either form of treatment, and abscess formation was more likely to develop in older cases of three or more days' duration before the start of therapy. When present their drainage by surgical incision is advised for successful treatment in conjunction with chemotherapy.

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CURARE—ITS RATIONAL USE AS AN ADJUNCT TO ANESTHESIA

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THE employment of curare as an anesthetic accessory for the enhancement of muscular relaxation is becoming more universal. The exact allocation of the drug's position in the field of anesthesiology cannot be determined yet, but clinical and laboratory experience with curare has uncovered certain desirable and undesirable properties, knowledge of which will assist in establishing its safe and rational utilization.

The coveted action of curare in clinical practice is that degree of depression of muscular activity that provides suitable relaxation at the site of operation without undue paralysis of the muscles of respiration or prostration of the peripheral circulation. Fortunately, this optimal state can usually be achieved by careful use of the drug and the frequency of its attainment is directly proportional to the experience of the employer. It is generally accepted that the best practice is to administer the Intocostrin* in small repeated doses intravenously until the optimal state is developed. The effect of the drug is complete within two to three minutes after injection and there is minimal delay in producing the necessary relaxation. Unnecessary relaxation and depression of respiration and circulation often accompany the use of single large doses of the drug.

Muscular paralysis is achieved by preventing the receptor substance of muscle from responding to acetylcholine. The muscle cells are unaffected and may be stimulated to full action in the presence of curarization. The nerve leading to the muscle is similarly unaffected by the curare. Intocostrin may be used with any of the anesthetic agents, but certain of these agents have appreciable degrees of curariform action of their own and less intocostrin is required when these agents are employed. Ether has a significant level of curariform action and small doses of curare are given in conjunction with anesthesia with this drug. Moderate amounts of intocostrin are needed when cyclopropane is the anesthetic agent but large doses are required to effect relaxation if nitrous oxide or ethylene produces the narcosis. Curare may be used for relaxation of the jaw and neck to facilitate endoscopy and for this purpose intermediate doses are used. Small doses may be administered to complement relaxation during spinal analgesia.

Curare has no analgesic property and in situations in which pain relief is necessary, the relief must be secured by the most appropriate agent and technique. Intocostrin is not an anesthetic drug and its safe and satisfactory use will depend upon the realization by the anesthesiologist and the surgeon that it is properly employed only as an adjunct to anesthesia. States of uncon-

Presented at the Third Annual Meeting of the Central Surgical Society, Chicago, Ill., Feb. 22-23, 1946.

*Manufactured by E. R. Squibb & Sons, New York, N. Y.

sciousness and apparent anesthesia can be produced by large amounts of curare and the drug has been used as the sole agent for surgical procedures, but there is no more justification for using intocostrin in this manner than there is in using pentothal alone for anesthetic purposes. Both effect so-called anesthesia only when used in excessive concentrations in the blood stream.

Curare, according to experimental and clinical data, has no direct effect on the heart. It may produce depression of the blood pressure if given in large doses during a short period of time. The circulatory detrusion is brief but in patients with labile peripheral circulations, the hypotension may be profound and refractory to treatment. In the later type of case, it is conceivable that the hypotension might precipitate a fatal termination of the anesthetic procedure.

The small intestine consistently exhibits brief cessation of peristalsis and somewhat longer periods of loss of tone. The interruption of peristalsis is of short duration and normal intestinal tone is restored soon afterward. Morphine and cyclopropane obliterate the curare effect.

It was originally thought that curare had no action on the lung but recently cases have been reported in which severe degrees of bronchospasm have followed the administration of the drug. It is not clear yet whether the bronchospasm is due to the curare action or whether it is due to prostigmine which is used to overcome respiratory muscle paresis due to the curare. Additional curare seems to relieve the spasm. Artificial ventilation with oxygen is imperative during the bronchospasm, and atropine in large doses intravenously may be useful in overcoming the constriction of the bronchiolar muscles. This complication has appeared only in patients receiving large amounts of the curare.

The effect of intocostrin on the uterus has not been thoroughly studied. A number of patients have been given curare for purposes of producing abdominal muscle relaxation during cesarean section without any apparent adverse effect on uterus or infant.

There is minimal detoxication of the curare in the liver and most of it is excreted unchanged by the kidney. Although it might be surmised, there is no evidence as yet that liver or kidney damage results in cumulative depression.

SUMMARY

Curare has proved useful as a means of obtaining improved muscle relaxation during anesthesia. It appears to be a safe drug when it is used in the proper fashion. Its chief disadvantage is the relatively narrow margin between the optimal dose and the dose producing respiratory paralysis. It should be used only when means of efficient artificial respiration and prostigmine are immediately at hand. It should be used only by those experienced in the science and art of anesthesia and it should not be used to cover up errors of commission and omission in the anesthetic technique. It will gain and retain respect as a useful adjunct to anesthesia if it is employed within the limits of its pharmacologic properties and it is not abused by excessive and indiscriminate use.

THE ROLE OF CANCELLOUS BONE IN PLASTIC SURGERY

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MOWLEM, in 1942, told me that he had been using cancellous chip grafts from the iliac crest to repair bone loss about the face, with very surprising results. Not only was union occurring much more rapidly than when cortical grafts were used, but these grafts appeared to have a definite degree of resistance to infection. Later, in discussing the question before the Congress on Wound Healing in Cambridge in 1943, Mowlem stated that all grafts could be divided into two groups: those which died and were replaced, and those which lived. He placed cancellous chip grafts in the latter group and his statement appears to have been unchallenged in spite of the fact that it has long been an accepted statement that all bone, separated from its circulation, dies. Stimulated by him, I have been using cancellous chip grafts since and their use is now routine for certain types of repair in the division of plastic surgery at the Department of Veterans Affairs' Christie Street Hospital, Toronto, and in the division of plastic surgery, Toronto General Hospital.

Cancellous chip grafts have been used to repair defects in the skull, malar bone, mandible, and, to some extent, in the hand. Properly done, that is, with thin shinglelike chips laid in staggered rows, one above the other, and in good contact with living bone at the circumference, skull defects of small size can be closed adequately. One cannot move the grafts by moderate pressure at the end of ten days. Closure of skull defect by this method means that future x-ray studies of the patient's head can, if necessary, be done without difficulty. On the other hand, our experimental work indicates that the chips become quite adherent to the dura mater. Whether or not this is a real disability must be left to the neurosurgeons.

Malar defects, and defects about the orbit, can be repaired by molding cancellous chips into proper shape to eliminate the defect. The chips must be in adequate contact with living bone freed of periosteum.

The largest field of usefulness to date has been the repair of nonunion of the mandible. Sixty-one cases were analyzed for this communication. The largest defect in the series was one and one-half inches. Sixty united without further trouble. In one case the graft united at one end only. Union, particularly in small defects, occurs within twenty-eight days. In larger defects solid union develops in six to eight weeks.

Experience has corroborated Mowlem's statement that mild infection does not result in loss of the grafts. Thus, in one instance, cancellous chip grafts were placed in the defect after a pathologic fracture infected with streptococci was cleaned out; in four instances ununited fractures which still had sinuses present were operated upon; and in seven cases grafting was done within two

Presented at the Third Annual Meeting of the Central Surgical Association, Chicago, Ill., Feb. 22-23, 1946.

weeks of healing following sequestrectomy. Primary healing followed by solid union occurred in all except the one case mentioned previously, and in this instance a sinus was present at operation. An opening was made into the mouth, accidentally, on three occasions without postoperative complications.

Cancellous chip grafts have been used in hands only to speed union of a cortical, or part cortical, graft.

Absorption has occurred in two instances in skull defects. One was a parietal defect, one a temporal defect. I believe absorption occurred in the latter because there was insufficient contact with living bone. The former was the result of an insufficient number of chips. I have not seen any case of absorption where chips were used to repair mandibular defects.

Considerable experimental work has been done to test Mowlem's contention that cancellous grafts lived. The work was carried out on dogs. Sections, obtained at intervals, have been studied by Dr. A. Ham, professor of histology in the University of Toronto. It would appear that cancellous chip grafts die and are gradually absorbed and replaced. Some small areas of newborn formation from the endosteum, and possibly marrow cells, were observed.

Cancellous chip grafts have a very definite and valuable place in plastic surgery, in my opinion. Contrary to most stated opinions, I believe, from experimental evidence, that the bone cells of such transplants die. Speed of union is the result of the marked stimulus to bone formation from periosteum, bone, and endosteum of the recipient site, and the ease with which cancellous chips may be overlaid and replaced. I am at a loss to account for the reaction of cancellous chip grafts to infection.

A METHOD IN THE MANAGEMENT OF MULTIPLE FACIAL FRACTURES

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A METHOD of treating gross fracturing of the facial bones will be presented. This is merely a modification of other existing methods with the application of a nasal stirrup to support the fractured nasal fragments and the insertion of submalar wires. Interosseous wiring is used here and has been employed during World War II with no untoward difficulties.

In Fig. 1 are shown the fractures of the nasal bones, both malars, maxilla, and mandible. There is gross comminution of the front face of the maxilla, of the lamina papyracea and the ethmoid labyrinth, with the nasal bones themselves, fractured backward into it. The problem is felt to be one of restoring alignment of the nasal fractures and the maxilla early, and fixing it so that drainage from the nose and sinuses can be maintained from the beginning. No intranasal packing is used and the nose is kept shrunk down with ephedrine postoperatively. Note that the malars have been displaced outward, backward, and rotated downward.

In Fig. 2, *A* are shown the interosseous wire loops between the two external angular processes and the frontal bone, after malar reduction. These are inserted into drill holes made through small supraorbital incisions just above the outer third of the eyebrows. A loop of wire has been passed through each of the first loops and, with a probe, drawn downward behind the malar bones and brought out in the upper buccal sulci on each side. It is obvious then that traction forward on these two wires in the upper buccal sulci will draw the malars inward and rotate them forward and upward on the fulcrum at the external angular processes. Two through-and-through wires have been passed through the ascending rami of the maxillae and fastened over two small lead plates on each side of the nasal bridge, after reduction of the comminuted nasal fracture. These have been fastened to a stirrup, fashioned as shown. The teeth have been wired together over half-round, German silver wires, fastened to the maxillary and mandibular teeth, and the two submalar wires in the upper buccal sulci that have been free are tied around the upper dental bar on the maxillary teeth, well forward in the premolar area. These are drawn taut to maintain the malars in position.

The mandibular fractures have been reduced and a long facial bar is fastened to the half-round dental bars and to a plaster head cap. It is now seen that control has been gained of the maxilla, mandible, and malars. The stirrup supporting the nasal fragments is fastened to the long facial bar and control of all the fragments is attained for further support. During the early stages a

Presented at the Third Annual Meeting of the Central Surgical Association, Chicago, Ill., Feb. 22-23, 1946.

Fig. 1.—Lateral roentgenogram of skull showing fractures of ethmoid and nose, malars, maxilla, and symphysis of mandible. Note fractured neck of right condyle and the retrodisplacement of the left malar. It is rotated downward and outward.

Fig. 1.

A.

B.

Fig. 2.—*A*, Lateral roentgenogram of the skull taken immediately postoperatively. Note gap at glabella and open fracture line of anterior maxilla. *B*, Roentgenogram taken twelve days after initial operation. Appliances have been readjusted two days previously. Note closure of glabellar fracture line. Maxilla has been further reduced and submalar wires drawn tighter, swinging the malars forward and narrowing the face.

Fig. 2.

plaster of Paris chin support is added in some cases and is attached to the lateral sides of the plaster head cap. The accurate reduction is thus maintained.

The first patient shown was admitted after a motorcycle accident, with gross fracturing of the maxilla and mandible, flattening of the nose into the ethmoid, fracturing of the zygomatic arch, with widening and retrodisplacement of the malars. There was great swelling of the face. This man was checked carefully neurologically and had no pupillary changes. Neurologic examination was negative apart from unconsciousness and his condition was good.

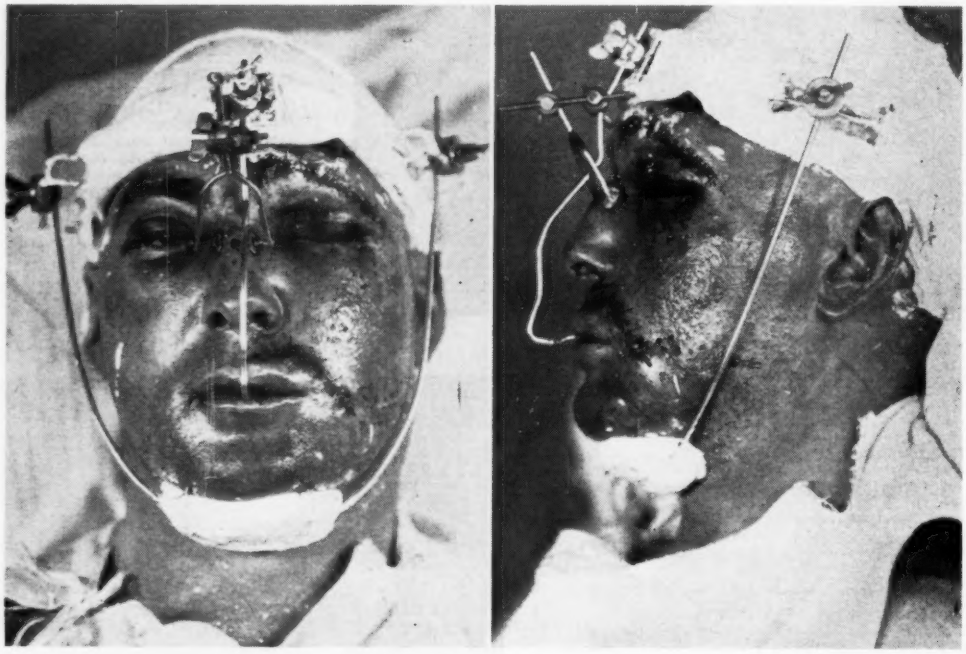

Fig. 3.—Immediate postreduction photograph; note forehead and cheek lacerations.

X-ray of the facial bones showed the extent of the fracturing (Fig. 1), with the position of the malars as described previously. After the reduction of the fractures, with the facial wires in position, and after the swelling had subsided (about ten days after operation), comparison with postoperative roentgenogram (Fig. 2, *A*) and with a previous photograph was made. The fragments were readjusted by means of loosening the nasal and forehead bolts, shortening the face, drawing the jaw fragments further forward, and readjusting the nasal length. The face was too wide and the submalar wires were drawn more tightly in the upper buccal sulcus, to narrow the malar positions. Figs. 2, *B*, 3, 4, and 5 show the same patient and his final postreduction roentgenogram after four weeks. The appliances are left for four or five weeks and then removed.

I have so treated twenty-one patients, with good results and there have been no complications from the interosseous wiring. The submalar wires were removed by simply cutting them off in the buccal sulci and withdrawing them by means of the small pull-out wires left in the temporal region.

Fig. 4.—Photographs taken after ten days. Appliances have been readjusted after swelling subsided and more accurate reduction has been accomplished.

Fig. 5.—Photographs taken after four weeks. Right submalar wire has been withdrawn, after it was cut off in the right upper buccal sulcus. Left pull-out wire is seen emerging on the left side of the forehead.

CONCLUSION

The method presented is merely a modification of other existing methods with application of the stirrup for maintenance of support of the nasal fragments, and with the use of submalar wiring. It is simple and requires no special equipment except perhaps the nasal stirrup and bolts. For the external fixation, coat-hanger wire and adhesive can be used and bent in any required position. This will serve equally as well as the more elaborate appliances shown, and its success depends solely upon the ingenuity of the operator.

The simplicity of the realignment of the malar fractures, the nasal fragments, and the jaw fractures after swelling has subsided has been demonstrated, and it is felt that better late cosmetic appearances can be expected.

TARDY MEDIAN PALSY; MEDIAN NEURITIS; MEDIAN THENAR NEURITIS AMENABLE TO SURGERY

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IN THE analysis of the cases of affections of the median nerve seen at the Mayo Clinic, thirty-eight cases were found in which the diagnosis might have been catalogued as tardy median palsy. In these thirty-eight cases the onset of symptoms was insidious and progression of the impairment of function of the nerve was gradual. Decompression of the median nerve by section of the transverse carpal ligament and neurolysis of the nerve at the wrist was effected in nine of this series of cases with good results.

In 1865, Sir James Paget described a case of latent impairment of the median nerve subsequent to an old fracture of the wrist in his lectures on surgical pathology. This case was the first of its type to be reported and the condition could be classified today as a tardy median palsy. Since this report only a few such cases have appeared in the literature.

Abbott and Saunders in 1933 brought attention to injury of the median nerve associated with fracture of the lower end of the radius. They mentioned that latent palsy of the median nerve may occur, but is rare, subsequent to this type of fracture.

Lewis and Miller, in 1922, reported a case typical of tardy median palsy encountered by Phemister. The patient had sustained a reverse Colles' fracture. Reduction was imperfect and eighteen years after the fracture, symptoms of compression of the median nerve developed.

The case of bilateral median thenar neuritis reported by Moersch in 1938 is included in our present series of cases. No deformity of the bones of the wrist was present; however, the patient obtained relief by section of the transverse carpal ligaments.

In 1941, Woltman reported a case of median neuritis associated with acromegaly and suggested that the neuritis was due to compression of the median nerve within the carpal tunnel brought about by proliferation of the tissue and that section of the anterior annular ligament might afford relief.

Zachary in 1945 presented two typical cases of compression of the median nerve within the carpal tunnel. In each the diagnosis was verified at operation, at which time section of the transverse carpal ligament was performed. In each case roentgenologic evidence of old bony derangement at the wrist was demonstrable.

The syndrome of tardy median palsy consists of any one or all of the following signs and symptoms: paresthesia, pain, atrophy, sensory impairment, and muscle weakness. In the differential diagnosis a lesion confined to the wrist must be distinguished from lesions of the cervical portion of the spinal

Presented at the Third Annual Meeting of the Central Surgical Association, Chicago, Ill., Feb. 22-23, 1946.

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cord, protruded cervical discs, scalenus anticus or cervical rib syndrome, neuritis of the brachial plexus, and progressive muscular atrophy. The differential diagnosis is not always easy. We have observed two cases which might well illustrate the confusion that may arise between scalenus anticus syndrome and compression of the median nerve at the wrist. One patient was a doctor whose examination revealed, in addition to a scalenus anticus syndrome, that he had an early thenar median palsy with neuritic pain. The two symptom complexes seemed to be separate but section of the anterior scalenus muscle afforded relief for both complaints. In the other case the conditions were reversed. The patient, a woman who was operated on elsewhere for a scalenus anticus syndrome without relief, showed definite evidence of a tardy median palsy from compression of the nerve at the wrist at the time of examination at the clinic.

In order that a clear-cut diagnosis of a tardy median palsy can be made or excluded, the examination of the patient should include a careful neurologic examination, the Adson or other maneuvers for demonstration of the scalenus anticus syndrome, roentgenograms of the wrists and cervical part of the spinal column, in addition to the general physical examination.

Diagnosis is simplified if there is a history of fracture of the wrist and the roentgenograms show an old deformity of the carpal bones or of the distal end of the radius or ulna or both.

Occasionally there may be a tumor mass at the wrist which is likely to be painful on palpation. This finding gives rather conclusive evidence of the site of the lesion.

DATA ON CLINIC SERIES

The thirty-eight patients in our series presented themselves at the clinic with varying degrees of atrophy of the lateral aspect of the thenar eminence with its accompanying muscle weakness. Sensory impairment, being absent in ten cases, was noted to be of varying degrees over the distribution of the median nerve in the hand in the remainder. Fibrillary twitching was never present in any of the cases. Symptoms had been present from two weeks to ten years at the time of admission. The onset was characterized almost always by paresthesia, but only thirteen of the thirty-eight patients ever complained of actually having pain. There were eight cases in which old deformities of the bones of the wrist were demonstrated in the roentgenograms. Involvement of the carpal bones was more frequent than involvement of the distal portion of the radius or ulna. The fractures had been sustained from twenty to fifty years prior to the onset of symptoms. Neuritic pain was experienced by only two of these patients. Surgical procedures were performed in four of these eight cases with moderately good results. Surgical procedures for relief of tardy median palsy were employed in nine of the thirty-eight cases and in the data on these cases which follows we are attempting to draw attention to the amenability of median nerve involvement of the type described to surgical treatment.

A synopsis of the nine cases of tardy median palsy in which operation was performed is given in Table I. In four, as mentioned previously, roentgeno-

TABLE I. TARDY MEDIAN PALSY; SYNOPSIS OF NINE SURGICAL CASES

CASE	AGE (YR.) SEX	OCCUPATION	AFFECTED HAND	PRESENTING COMPLAINT	DURATION (YR.)	FIRST SYMPTOM	CLINICAL FINDINGS				DEFORMITY OF BONE OF WRIST	RESULTS SATISFACTORY
							S.I.	M.W.	P.	A.		
1	44* F	Housewife	R†	S.I., A.	3	P	+	+	+	+	+	?
2	41* M	Farmer	R	P., S.I., M.W., A.	15	S.I.	+	+	+	+	+	?
3	55 M	Farmer	L	Pain	6	P.	+	+	+	0	+	+
4	64* M	Physician	L	P., A.	2	P.	0	+	+	+	+	+
5	50‡ F	Housewife	R	Pain, P., S.I.	10	P.	+	+	+	+	0	+
6	28§ M	Farmer	L	Pain, P., A.	8	Pain	+	+	+	+	0	+
7	55 M	Rope elevator operator	R L	Pain	4	Pain	+	+	+	+	0	+
8	73 M	Merchant	R	P., Pain	1	Pain	+	+	+	+	0	+
9	71 F	Housewife	R	Pain, Ulcers	1	Pain	+	+	+	+	0	+

*Fracture sustained more than twenty years prior to onset.

†R, right; L, left; S.I., sensory impairment; A., atrophy; P., paresthesia; M.W., muscle weakness; +, positive; 0, negative.

‡Acromegalic.

§Etiology found to be a neuroma at the wrist.

logic evidence of an old deformity of the bones of the wrist was present. In Cases 1, 2, and 4 the patients gave a history of having fractured the wrist more than twenty years prior to the onset of the present syndrome. The roentgenograms of the affected wrist in Case 3 showed bony proliferation with cystic degeneration of the distal end of the radius. Aside from the absence of atrophy in Case 3 and the absence of sensory impairment in Case 4, all the symptoms and signs of tardy median palsy were present in the nine cases.

The procedure employed in decompressing and freeing the median nerve is a relatively simple one. A longitudinal incision through the skin over the volar surface of the wrist is made and the median nerve is identified just proximal to the transverse carpal ligament. At this point there is usually a fusiform swelling of the injured nerve. A more proximal exposure of the nerve is needed to demonstrate a normal portion of the nerve. Then the transverse carpal ligament is divided. The nerve beneath then presents itself but is compressed and often discolored. The exposure obtained is illustrated in Fig. 1. Care must be taken in section of the ligament as a small sensory branch of the median nerve superficial to the ligament and the motor branch, which makes its exit at the distal border of the ligament, render themselves susceptible to injury.

We have considered it wise to perform neurolysis on the constricted portion of the nerve so that all tension on the nerve fibers will be released. This is effected by several razor blade incisions through the epineurium parallel to the axis of the nerve trunk. The subcutaneous tissue is approximated with catgut sutures and the skin is closed with interrupted silk sutures. A well-padded dressing is applied and the wrist is immobilized until the wound is healed. The patient is advised to use the hand cautiously for another four weeks.

Supplementary procedures were used in two of the cases. In one of our series (Case 3) arthrodesis with a bone graft was done because of the cystic degeneration of the distal end of the radius. In another case (Case 4) excision of the proliferated synovium of the tendon to the thumb as well as the decompression of the nerve was felt to be necessary.

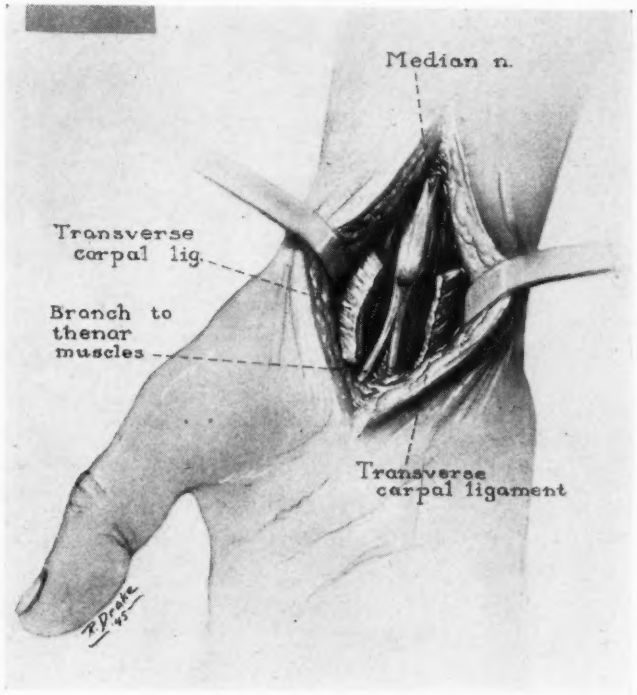

Fig. 1.—The surgical procedure used in Case 1 for tardy median palsy. The transverse carpal ligament has been divided and the median nerve is exposed. Fusiform swelling of the nerve at the proximal border of the ligament may be noted.

REPORT OF CASES

To illustrate these four cases of tardy median palsy associated with a bone deformity of the wrist, Case 1 is reported.

CASE 1.—A woman, aged 44 years, was seen in the Section on Neurology at the Mayo Clinic because of partial loss of function in the right hand. Twenty years previously, she had fractured her right wrist and was treated appropriately. About three years prior to coming to the clinic, paresthesia began over the distribution of the median nerve in the right hand. Atrophy of the right thenar eminence with diminished sensation over the median distribuiton was noted on examination. There was no pain. The roentgenograms showed deformity of the right wrist as a result of an old Colles' fracture (Fig. 2, *a* and *b*). A diagnosis of right tardy median palsy was made.

A compressed median nerve was freed by dividing the transverse carpal ligament. The nerve measured 5 mm. in diameter 3 cm. above the transverse carpal ligament, whereas at the ligament it measured 1 cm. or twice as much. The nerve beneath the ligament was definitely compressed (Fig. 1). Neurolysis was performed on the compressed nerve.

Another patient (Case 5) who had typical acromegaly presented the characteristic syndrome of a tardy median palsy. The surgical findings and the

results obtained from section of the transverse carpal ligament and neurolysis of the nerve confirm the suggestion made by Woltman in 1941 that relief might be obtained in such a case by operation.

Fig. 2 (Case 1), *a* and *b*.—The right hand and forearm showing evidence of an old Colles' fracture and persisting deformity at the wrist. The patient had right tardy median palsy.

CASE 5.—A woman, aged 50 years, who had undergone an enucleation of an adenoma of the pituitary at the clinic seven years previously, returned because of pain and loss of use of the right hand. The patient had typical acromegaly. She had had several examinations in the seven years since the operation and usually she had complained of generalized paresthesia and pain in all extremities. On examination, sensory loss over the distribution of the right median nerve in the hand, atrophy (Fig. 3), and muscle weakness of the right thenar eminence were noted. Roentgenograms of the hands were read as negative.

Division of the transverse carpal ligament was performed. The median nerve was diffusely swollen proximal to the ligament, and compressed and discolored beneath. The accurate measurements were 10 mm. at the promixal border of the ligament and 7 mm. above this level. The compressed portion of the nerve measured 9 mm. at the beginning of the constriction and 6 mm. well under the ligament.

CASE 6.—A tumor of the median nerve was uncovered at operation in the patient. In the eight years that symptoms had been present, pain was the first and most characteristic symptom. On examination a tumor mass was palpable at the wrist. The tumor, a neuroma, was exposed and neurolysis was performed. The expected relief of pain was noted postoperatively.

Cases 7, 8, and 9 can be considered together as they depict a group in which the etiology cannot be explained by roentgenogram or positive clinical findings. History of prolonged occupational trauma lacks constancy. By exclusion of other conditions, the lesion was localized at the wrist and, at operation, compression of the median nerve was found within the carpal tunnel. To illustrate this group, Case 7 is reported in detail.

Fig. 3 (Case 5).—The hands of the acromegalic patient who had tardy median palsy of the right hand. Some atrophy of the outer aspect of the right thenar eminence can be detected.

Fig. 4 (Case 7).—The hands of a patient who had bilateral tardy median palsy. Atrophy of muscles of the outer or lateral aspect of the thenar eminence may be seen.

CASE 7.—A man, aged 55 years, a rope elevator operator, came to the clinic because of pain and loss of use of a part of both hands. The present complaint had begun four years previously. Neurologic examination revealed atrophy (Fig. 4) and weakness of the thenar muscles with diminished sensation over the distribution of the median nerve in both hands. Subjectively, pain and paresthesia were profound. Roentgenograms of the cervical portion of the spinal column and carpal bones showed slight arthritis.

The transverse carpal ligaments were divided and neurolysis performed on the compressed nerves.

In the six cases in which pain was one of the presenting complaints, relief was obtained by operation. These patients likewise obtained the greatest improvement in the neurologic findings from operation. The improvement in the neurologic status has varied inversely with the degree of the impairment of nerve function. The more complete nerve palsies present, the less recovery occurred.

The trophic disturbance characterized by ulcers on the tips of the index and middle fingers of the affected hand in Case 9 completely cleared following decompression of the median nerve. The results of operation in Cases 1 and 2 are reported as questionable because it has been impossible to trace these patients. This does not mean that operation failed to benefit them.

COMMENT

Failure to make the diagnosis of tardy median palsy early and to institute surgical treatment prevents obtaining the best results of operation. The same is true of many other surgical problems. As mentioned previously, of the thirty-eight patients with tardy median palsy observed at the Mayo Clinic, only thirteen had ever complained of pain and six of these underwent operations. We feel that relief of pain can be promised to the patients with pain, but the degree of return of nerve function cannot be predicted in all cases. It is possible by surgical means, however, to prevent further impairment of nerve function by decompression of the median nerve in an early tardy median palsy.

SUMMARY

In nine of the thirty-eight cases in which the syndrome of a tardy median palsy with or without associative neuritic pain was encountered at the Mayo Clinic, operations were performed for this condition. At operation, the transverse carpal ligament was divided and neurolysis was performed on the compressed median nerve. The results in these surgical cases have been satisfactory.

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FUNDAMENTALS OF TECHNIQUE IN THE TRANSVERSE ABDOMINAL INCISION

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A CONTROVERSY of thirty years still leaves the question of the laparotomy wound of choice an open one. Before a new generation takes up the cudgel for transverse or vertical incisions, it would do well to recall some sections of *Gulliver's Travels*. There are times when surgery could use the services of a satirist like the Irishman Swift, who set his men of Lilliput to wage a civil war over the question of the proper end at which to amputate a soft-boiled egg. Now, in 1946, both the vertical and transverse approaches have stood the test of time. And time has done much to soften the rancour of this feud.

The standard textbooks fail to describe in detail any technique for an all-purpose transverse incision. Most surgeons have been brought up to select a vertical incision for major abdominal work. Many established men are diffident about changing their approach, and may find it difficult to locate a precise description of an operative technique for transverse incision. Many men now using transverse technique are likewise diffident about instructing their peers or betters in so fundamental a procedure as opening an abdomen. Finally, certain criticisms of the transverse technique remain unanswered in many minds. For these reasons it is felt that a somewhat detailed technical description of a transverse incision of wide utility may not be out of place.

A short discussion of some *general considerations* is necessary, to deal with some of the objections encountered. The most common criticisms of a transverse incision are as follows:

1. That there is danger to nerves, especially when one or both recti abdominis muscles are cut. It is probably true that in dividing the rectus transversely some filament of its nerve supply is sectioned. In clinical experience it is found that one thoracic nerve can be sacrificed without evidence of rectus paralysis. The thoracic nerves within the abdominal wall show branches and anastomoses; the innervation is more plexiform than generally imagined.[5] The recti are not long-bellied muscles from the point of view of innervation, and the objection to sectioning them, derived from analogy to long muscles of the extremities, does not hold. If the laparotomy is performed in such a way as to visualize the nerves which are encountered, these can generally be spared. It is true that if two nerves are cut a bulge of rectus may result, and in the lower incision the functional integrity of the internal inguinal ring may be jeopardized.

2. That it is wrong to cut muscle across, from the viewpoint of healing. In answer it can be stated that healing does occur at least as commonly as when the rectus is split in its long axis. Few muscles are so well endowed with sheathing on both sides. The oblique aponeuroses which form the two sheaths are somewhat interlaced, but the preponderant direction of these fibres is trans-

Presented at the Third Annual Meeting of the Central Surgical Association, Chicago, Ill., Feb. 22-23, 1946.

verse, and a transverse section line holds sutures better than a vertical one. The close association of the rectus muscle to the anterior sheath mitigates retraction; the resultant muscle scar is functionally insignificant.

3. That it is slower to close. In answer it may be said that the tendency to evisceration is not great, even if the patient should be straining somewhat. This often makes closure actually quicker and more satisfying than in many instances of the vertical technique. But even if the closure is somewhat slower when a large incision is being used, it is only a matter of a few minutes. If the anesthetic and supportive activities are satisfactory, the view may quite properly be taken that the surgeon's time is of no importance when the expenditure of a few more minutes may be to the advantage of the patient.

4. That adequate exposure of the upper abdomen is not obtained in the presence of a narrow costal angle. This difficulty may be overcome as a rule by adequate extension of the incision to both flanks. It is only fair to add that no routine incision is exposed to more postoperative tension than a long vertical one in the presence of a narrow costal angle. In this circumstance the narrow stretch of soft tissue across the epigastrium provides little elasticity. Both costal and diaphragmatic breathing put severe demands upon the upper end of such a wound.

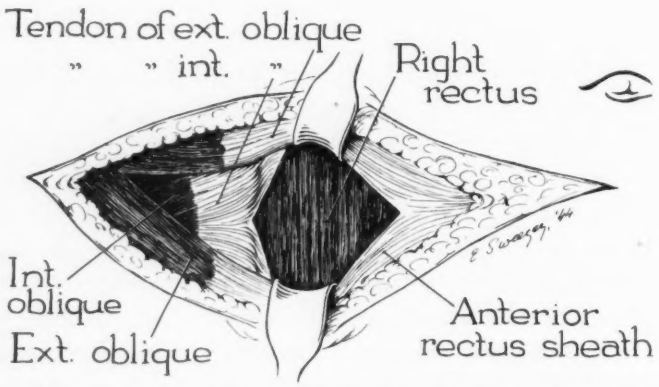

Fig. 1.—Right-sided incision below umbilicus (see Step 3 of text). The anterior rectus sheath has been incised, and the external oblique split laterally and upward.
(Figs. 1-4 from Gurd, Fraser B., S. Clin. North America 25: 271-284, 1945.)

The transverse incision to be described should be thought of as a belt-line incision, for its lowest feasible limit is the belt line, and its uppermost level not much higher.[2, 3, 4] It must be appreciated that the choice of locations of a major incision in the transverse plane is limited. The plane of the incision must be restricted to the narrow band between the crest of the ilium and the costal cartilages. Otherwise the advantage of extension far laterally is lost. In effect there are only two locations for an incision of this type, either just above or just below the umbilicus, each passing within one inch of it. Many men have been discouraged at the first attempt because they have placed the incisions either too high or too low, and have been unable to develop them laterally because of interference from either the pelvis or the costal margin.

TECHNIQUE

In the interests of clarity, only a low, right transverse incision will be described, such as is useful for work on the appendix, cecum, or ileum. The steps in *making the incision* follow:

1. With the surgeon on the patient's right side, the upper limits of the pelvis are defined, and a line is selected which will pass above this level. This will generally fall just below the umbilicus.

2. The skin is incised from beyond the midline to the right flank. The rectus sheath need not be widely cleaned, but the external oblique at the lateral end of the wound should be well exposed.

3. In the same plane as the skin incision the anterior rectus sheath is divided down to muscle, and the cut is extended laterally beyond the lateral margin of the sheath through the aponeurotic fibers of the external oblique. When the muscular portion of the external oblique is reached the incision turns upward slightly to become muscle splitting, and this split may be extended as far upward and laterally as desired (Fig. 1).

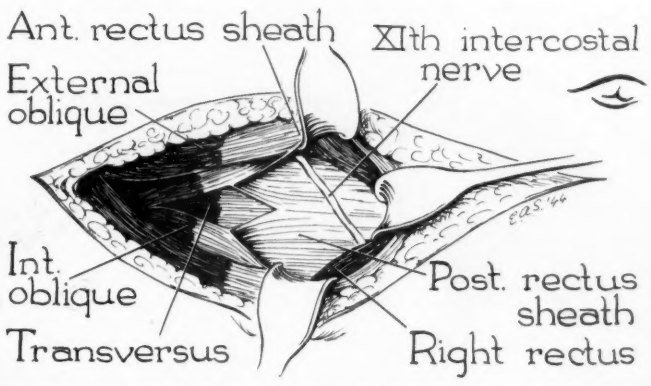

Fig. 2.—Right-sided incision below umbilicus (see Steps 4 and 5 of text). The rectus muscle is retracted medially. The internal oblique has been incised at the lateral margin of the sheath, at which site the transversalis and peritoneum will be incised as Step 6.

4. Using the scalpel handle or blunt scissors, the lateral edge of the exposed rectus muscle belly is now lifted. Usually the eleventh thoracic nerve or a branch of it is then seen just entering the lateral edge of the sheath and coursing downward and medially to enter the rectus muscle. If the nerve is not seen, it will usually be found that it has been lifted with the muscle. Two index fingers are then inserted behind the rectus belly, and the muscle is freed from the posterior sheath completely for about one to two inches above and below the plane of the incision. The rectus with its nerve is then retracted medially while the lower edge of the divided external oblique is retracted downward and laterally at the lateral end of the wound.

5. The thin sheath of the internal oblique is next divided, beginning at the lateral edge of the rectus sheath and extending laterally and downward in the direction of the muscle fibers (Fig. 2).

6. The posterior rectus sheath and peritoneum are opened at the lateral margin of the sheath and the incision is extended medially almost to the mid-

line beneath the retracted muscle belly. The extension of the incision laterally is accomplished principally by hand, splitting internal oblique and transversalis muscles in the direction of their fibers. This requires firm but careful finger pressure. Vessel bundles, which may appear across the split, can be dealt with without being torn. The twelfth thoracic nerve will likewise appear to view, and perhaps lateral to it the iliohypogastric. These can be freed and retracted laterally without being injured, provided one is aware of their course beneath the internal oblique muscle. The peritoneum is split laterally to the outer end of the wound.

7. The incision is now complete for most purposes. If advisable for further exposure, the rectus muscle may be cut across. The principal vessel encountered is the main trunk of the deep inferior epigastric artery, with its vein, which usually lies on the posterior surface of the rectus belly a little lateral to its center. A second vessel may require ligation, but rarely more (Fig. 3).

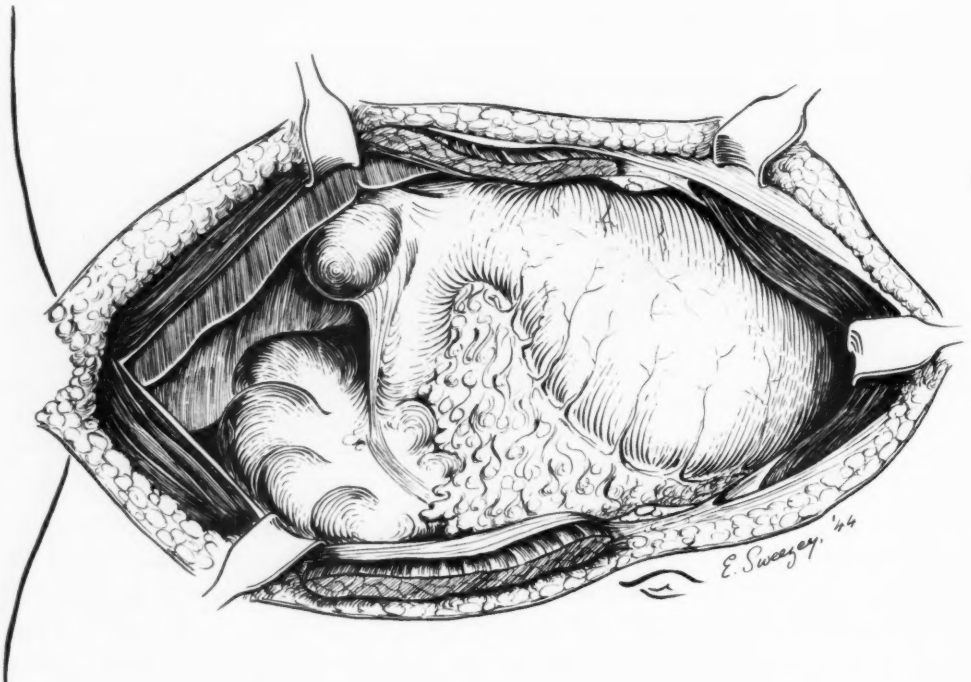

Fig. 3.—Right-sided incision above umbilicus (see Step 7 of text). The maximal exposure with one rectus muscle divided is shown.

If more exposure still is called for, the same rational step-by-step procedure is extended to the opposite side, and the patient is hyperextended on the table. No better view of the pelvis is attainable than that given by a full length, flank-to-flank, subumbilical transverse incision.

In the upper abdomen the incision is sited on a plane which will clear the lowest portions of the thoracic cage (Fig. 4). This is usually just above the

umbilicus. The same steps as already detailed apply to this approach, save that the falciform ligament must also be divided if the right rectus is sectioned.

The *closure* must be just as thoughtfully planned. A good plan is to divide the incision mentally into two halves—we are still considering a lower right-side incision. The half to the medial side of the outer margin of the sheath will be closed in two layers: one for peritoneum and posterior sheath, one for anterior sheath. The lateral half resembles a muscle-splitting McBurney incision. As such it will call for three layers of sutures, namely, one for peritoneum and transversalis, one for internal oblique, and one for external oblique. It is well to adjust the table to jackknife the patient before the closure is begun.

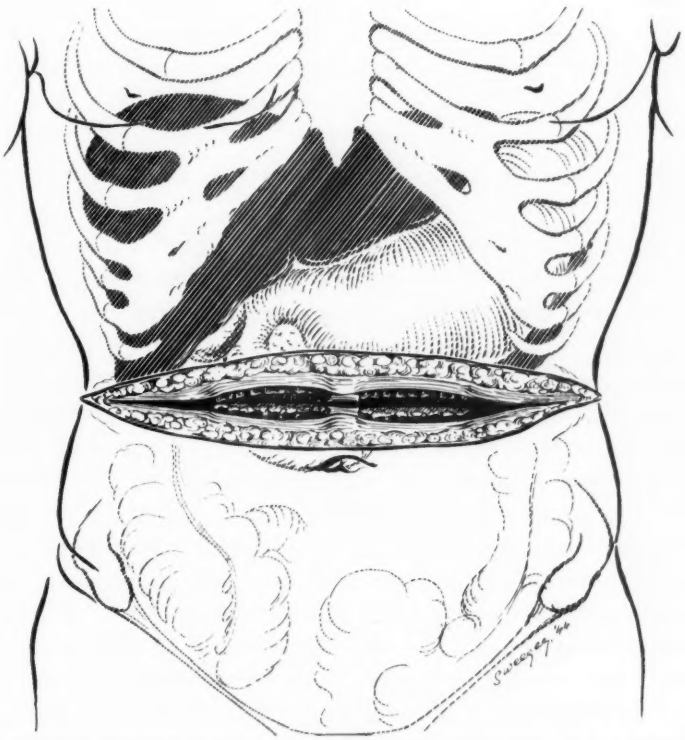

Fig. 4.—The maximum belt-line incision above umbilicus is shown. This capacity for extension to both flanks is always at hand, although not often necessary.

The steps of closure follow:

1. Beginning at the medial end, the peritoneum and posterior rectus sheath are closed as one layer. If a continuous suture is used it should be securely locked when the outer margin of the sheath is reached. It is then continued laterally to close the peritoneum. The transversalis may be approximated in this suture line. If the suture is not locked at the lateral edge of the sheath, the relatively lesser rigidity of the structures in the lateral half of this layer may lead to puckering in this area and cause the suture to loosen in the area of the posterior sheath. If an interrupted technique is used this pitfall does not apply.

2. The internal oblique lateral to the sheath is gently approximated with interrupted sutures, beginning at the lateral margin of the sheath and working outward.

3. The final musculofascial layer is closed, beginning again at the medial end. The closure is the same whether the rectus muscle has been divided or not. It is sufficient to effect a firm closure of the anterior sheath. Indeed, it is undesirable to bite deeper into muscle, because the thread will cut out of the muscle fibers and loosen the aponeurotic repair. As before, when the lateral edge of the sheath is reached, a continuous suture should be either locked or discontinued, following which the external oblique in the lateral half of the wound is closed.

4. The fat and skin are closed by any rational method. The gridiron nature of the outer half of the wound makes deeply placed retention sutures undesirable. Subcutaneous retention sutures do no harm, but have been largely abandoned by the users of this technique. A narrow transverse dressing is applied without constriction. Abdominal binders are avoided. The closure is now complete.

In conclusion, one should mention briefly a few advantages of this incision. For the younger surgeon, especially, the great point of the incision is its capacity for extension. A twenty-inch incision from flank to flank gives unrivaled exposure in all directions with a minimum of forceful retraction, yet no marked increase in the complication rate has been noted by the use of these great wounds. In vertical incisions, the principal resistance to good exposure is offered by the recti muscles. No method of removing this resistance can surpass the simple expedient of cutting them across. The greatest strength of the incision is its role in the reduction of postoperative complications.[1, 5] Costal respiration is less impeded by pain and spasm than when the epigastrium has been insulted by a high vertical wound. The prophylaxis of atelectasis is attended by less difficulty; effective cough returns sooner. Early ambulation has been credited with a reduction in the incidence of almost all the common complications. The transverse incision can be followed by early rising with considerable regularity and with less pain to the patient. It is safe to say that early rising was practiced by the users of the technique for many years before the present enthusiasm took hold.

SUMMARY

Some objections to the transverse abdominal incision have been dealt with.

The importance of accurate placement of the belt-line incision has been stressed.

The details of technique of both the opening and the closure have been outlined. Certain of its advantages have been mentioned, and its applicability to early ambulation has been emphasized. It is felt that no fundamental principles are violated by this particular transverse incision, sited as it is in the line of the body's most important flexion crease.

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RESECTION OF THE DUODENUM AND HEAD OF THE PANCREAS FOR CARCINOMA

An Analysis of Thirty Cases

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(From the Division of Surgery, Mayo Clinic)

PRIOR to ten years ago it was only on rare occasions that an operation thought to be curative was utilized for carcinoma of the ampulla of Vater. The usual procedure was palliative in nature and the occasional resection was in most instances only a local excision done transduodenally. In the last decade, due largely to the pioneering efforts of Whipple, a radical operation has been evolved for carcinoma in this region. This operation which usually can be carried out in one stage offers the patient a chance for cure not previously available, with a mortality rate approaching that for palliative procedures before the advent of vitamin K. Since this operation, which consists of radical resection of the duodenum and head of the pancreas, has been performed at the Mayo Clinic in thirty cases prior to Jan. 1, 1946, for carcinoma in and about the head of the pancreas, it was felt that an analysis of these cases should provide valuable information about the treatment of malignant lesions in this region.

In recommending operation for the cure of malignant lesions in any location, three objectives should be constantly before the surgeon. First, the operative procedure should be radical enough to give a reasonable opportunity for cure. Second, the operative mortality of the procedure should not outweigh the prospects of cure. Third, the patient should be left in as normal a condition as possible.

In applying these objectives to the subject under discussion, namely, carcinoma in and about the head of the pancreas, it is as yet too early to determine the percentage of cures from our series as the length of time since operation is too short. All but four of the patients have been operated on in the past two years. As might be expected, the survival of patients with carcinoma of the head of the pancreas following this operation is discouraging. Seven of the fifteen patients who had carcinoma of the head of the pancreas and survived the operation are already known to be dead, presumably of recurrent carcinoma five to nineteen months postoperatively. The status of one patient operated on three years ago is as yet undetermined. Another is alive one year after operation but has a recurrence, and six are alive and well without obvious recurrences three to seven months following operation. The survival thus far after resection for carcinoma of the ampulla is much more encouraging, only one of the seven patients having succumbed. The six others are alive and well, twenty-four, thirteen, twelve, ten, four, and four months, respectively, after

Presented at the Third Annual Meeting of the Central Surgical Association, Chicago, Ill., Feb. 22-23, 1946.

operation. In some instances it is impossible at operation to determine whether a carcinoma originates in the distal biliary ducts or the glandular substance of the pancreas, and the pathologist may have difficulty in determining this after the specimen has been removed; otherwise it might be possible to limit this extensive operation to the more favorable group, namely, cases of carcinoma of the ampulla. Until, however, a series of sufficient size and duration can be accumulated and analyzed for percentage of cures, it is our feeling that the operation is justifiable for both carcinoma of the head of the pancreas and of the ampulla of Vater.

RISK OF OPERATION

That the operation can be done without prohibitive risk, which is our second objective, is borne out by Table I. Thirty patients with six postoperative hospital deaths, or a mortality rate of 20 per cent, would not seem out of line when it is considered that this series includes all patients who have undergone radical resection of the head of the pancreas and duodenum for carcinoma of the ampulla, head, duodenum, or stomach at the Mayo Clinic to Jan. 1, 1946. Two cases of primary carcinoma of the duodenum which did not appear to originate in either the pancreas or bile ducts and one case of extensive carcinoma of the stomach involving the head of the pancreas are included in the thirty cases under consideration because the operation in these cases was similar to that employed for carcinoma of the ampulla or head of the pancreas. In this analysis the operative mortality rate is considered in relation to the technique employed but no evaluation is attempted of the survival of the patients beyond the immediate postoperative period. Seventeen patients who had carcinoma of the head of the pancreas underwent operation with two deaths, a mortality rate of 11.8 per cent. In four of these cases the operation was performed in two stages with one operative death (25 per cent mortality), which on comparison with the one-stage operation with a mortality of 7.7 per cent might appear unfavorable to the former procedure. This will be discussed later. Ten patients who had carcinoma of the ampulla underwent resection of the head of the pancreas with three deaths, or a mortality rate of 30 per cent. We have no adequate explanation for the 18 per cent difference in the mortality rate in the two groups. Less risk of operation ordinarily would be expected in the ampullary group as usually the operation is easier and is likely to be performed earlier in the course of the disease than for carcinoma of the head of the pancreas. Almost exactly the same percentage of both groups of patients was more than

TABLE I. RADICAL RESECTION OF HEAD OF PANCREAS FOR CARCINOMA: OPERATIVE MORTALITY

SITE OF LESION	OPERATION IN	PATIENTS	HOSPITAL DEATHS		
			NUMBER	PER CENT	
Head of pancreas (17 cases)	1 stage	13	1	7.7	11.8
	2 stages	4	1	25.0	
Ampulla (10 cases)	1 stage	7	2	28.6	30.0
	2 stages	3	1	33.3	
Duodenum and stomach (3 cases)	1 stage	3	1	33.3	
Total		30	6	20.0	

50 years of age so that the factor of age as an explanation for the higher mortality rate in ampullary lesions would not hold. It is likely that the addition of a similar number of cases to our series will tend to obviate this difference as it is still a small group from a statistical standpoint and probably the mortality rates following resection for carcinoma of the head of the pancreas and of the ampulla will in time approach similar figures.

The operative mortality figures at first sight might seem to contraindicate the two-stage operation, but further analysis does not justify this conclusion. The two-stage operation was performed in only seven cases with two deaths, a mortality rate of 28.6 per cent. This is too small a group for comparison with the one-stage group of twenty cases with three deaths, a mortality rate of 15 per cent. Furthermore, in two of the seven cases the surgeon stated that the patient was in too poor condition for a one-stage procedure. Both patients, however, survived the two-stage operation. Three additional patients had their first operation elsewhere and were referred to the Mayo Clinic for resection; two of these survived to leave the hospital and the third died from massive mesenteric thrombosis. This complication might result from either the one-stage or two-stage resection and the same is true for the other death which followed leakage from the closed duodenal stump. Certainly the two-stage procedure should not be indicted from our figures, for it has a definite place in the management of the patient who is in poor condition and has signs of hepatic insufficiency. Nevertheless, we both feel that in most instances a one-stage procedure can be executed just as safely. It eradicates the malignant growth at an earlier date, saves the patient the discomfort and expense of two major operative procedures and, in our experience, permits an easier and more rapidly executed resection.

The causes of the six operative deaths are given in Table II. Post-mortem examinations were performed in five of these cases. The first patient (Case 1) died after the second stage of the operation for removal of a carcinoma of the ampulla, 4 mm. in diameter. Leakage from the inverted stump of the third portion of the duodenum was responsible for the peritonitis. The resection was performed on July 28, 1941, and was the first operation of this type attempted at the Mayo Clinic. The second patient (Case 2) had submitted to a one-stage operation for resection of a carcinoma of the duodenum and after a stormy convalescence complicated by an external pancreatic or intestinal fistula died of a massive intra-abdominal hemorrhage three weeks after operation. There was evidence of leakage from both the gastrojejunostomy and the cholecystojejunostomy with resulting peritonitis at the post-mortem examina-

TABLE II. CAUSES OF SIX OPERATIVE DEATHS (FIVE POST-MORTEM EXAMINATIONS)

CASE	CAUSE OF DEATH	TIME AFTER OPERATION
1	Peritonitis, source: leakage from duodenal stump	8 days
2	Postoperative hemorrhage; pancreatic fistula	3 weeks
3	Uremia: peritonitis; source: questionable; no leakage	5 days
4	Leakage; peritonitis; hemorrhage (no post-mortem examination)	25 days
5	Coronary occlusion	10 hr.
6	Massive mesenteric thrombosis	20 hr.

tion. Uremia developed in one patient (Case 3) without preoperative evidence of renal damage. At post-mortem examination peritonitis was found but all anastomoses were intact and there was no evidence of leakage of bile or pancreatic juice. This patient had carcinoma of the head of the pancreas for which a one-stage operation was performed. It is entirely possible that a two-stage procedure might have permitted his survival. The fourth patient had a small carcinoma (8 mm. in diameter) of the ampulla and a one-stage operation was done. Although no post-mortem examination was permitted, death most likely should be attributed to leakage and peritonitis with some terminal bleeding twenty-five days after operation. In Case 5 a one-stage procedure was used also. The patient gave a seven- to eight-year history of angina pectoris but during this time he had tolerated moderate exercise well. He died of coronary occlusion ten hours after operation. He had remained in excellent condition up to the moment of his sudden death. Post-mortem examination showed the operative site to be in good order. The last patient had undergone cholecystojejunostomy at home and was referred to the clinic for resection. Although there was no obvious distant metastasis, the lesion was extensive and almost surrounded the superior mesenteric vein. It was possible to remove the tumor from the vein, which was traumatized more than usual. Twelve hours after operation, shock appeared which was not amenable to treatment with transfusions of blood and the patient died twenty hours following operation. At post-mortem examination a massive mesenteric thrombosis was found and the anastomoses were all intact.

TABLE III. OPERATIVE MORTALITY BY AGE GROUPS

AGE (YR.)	PATIENTS	HOSPITAL DEATHS	
		NUMBER	PER CENT
20 to 29	1	0	0
30 to 39	1	0	0
40 to 49	8	1	12.5
50 to 59	13	1	7.7
60 to 69	7	4	57.1

The operative mortality by age groups is given in Table III. The high operative mortality rate of 57.1 per cent for seven patients in the seventh decade is indeed noteworthy. A higher incidence of cardiovascular and renal disease is found among patients in this age group than among younger patients, and a higher mortality rate would be expected from any operation and most assuredly from resections of the magnitude of the one under consideration.

PROCEDURES USED IN RESTORATION OF CONTINUITY OF GASTROINTESTINAL TRACT AND DISPOSAL OF BILIARY AND PANCREATIC DUCTS

Since the thirty resections in this series were performed by ten different general surgeons at the clinic and we, the authors, operated on twenty between us, it could be expected in the development of this new procedure that the methods of restoration of the gastrointestinal tract and the disposal of the biliary and pancreatic ducts were manifold. Exactly eighteen different techniques were employed. This number indicates that the surgeons found it im-

portant to adapt and alter their techniques to fit the peculiarities of the individual patient, rather than to try to fit the patient to the particular technique. From our data, it is evident that for the most part any well-executed plan that does not compromise certain fundamental surgical principles will prove satisfactory.

In all cases in which resection was performed before the latter part of 1944, no attempt was made to re-establish continuity between the pancreas and intestine. Some patients had little difficulty with digestion of fats and maintained their nutrition; however, it was soon apparent that the majority had faulty digestion of fat and required pancreatin to maintain weight which was frequently considerably below normal. It was evident then that to accomplish our third objective, which was to leave the patient in as nearly normal condition as possible, we should direct our efforts toward getting the external pancreatic secretion back into the upper part of the intestine. Accordingly, in the last thirteen cases, the stump of the pancreas has been reimplanted into the upper part of the jejunum or stomach (Table IV). In most of these cases absorption

TABLE IV. OPERATIVE MORTALITY IN RELATION TO DISPOSAL OF PANCREATIC STUMP

OPERATIVE PROCEDURE	PATIENTS	HOSPITAL DEATHS	
		NUMBER	PER CENT
Pancreatic stump obliterated by suture	17	3	17.6
Pancreatic and jejunal or gastric anastomosis	13	3	23.1
Pancreaticojejunostomy (end-to-end)	7	3	42.8
Pancreaticojejunostomy (end-to-side)	5	0	0
Pancreaticogastrostomy	1	0	0

of fat is definitely better and the weight has been maintained for the most part without pancreatin. Definite information in this regard, however, will be forthcoming following the completion of studies by Doctors Comfort and Wollaeger after observing these patients for a period of time in the metabolic unit. The mortality rate of 17.6 per cent in those cases in which the pancreatic stump was obliterated, as compared with 23.1 per cent in those in which the stump was anastomosed to the stomach or jejunum, indicates that the latter procedure does not materially add to the mortality rate. Actually, we think a larger series will show that pancreaticojejunostomy is a safer procedure than obliteration of the stump, as the latter is more difficult than the former to accomplish satisfactorily. Although three deaths occurred in both groups, in each instance only one of the three could in any way be attributable to the disposal of the pancreatic stump. In Cases 1, 2, and 3 of Table II, in which the operative deaths are listed, the stump of the pancreas was obliterated and only in Case 2 did a fistula develop or was there evidence of leakage of pancreatic secretion at post-mortem examination. Since there was also evidence of leakage from both the gastric and biliary anastomoses, it may not be just even in this case to blame the disposal of the pancreatic stump. In Cases 4, 5, and 6 (Table II) end-to-end pancreaticojejunostomy was performed and in only Case 4 was there evidence of leakage, which may or may not have been at the pancreatic anastomosis as post-mortem examination was not carried out.

At first glance Table IV seems to indicate that the mortality rate was much better after end-to-side pancreaticojejunostomy than after end-to-end pancreaticojejunostomy. This observation again is not borne out by careful analysis of Table II, for as was just indicated, only in Case 4 might leakage have occurred at the site of the pancreaticojejunostomy and necropsy was not carried out. The other two deaths in this group were due to coronary occlusion (Case 5) and mesenteric thrombosis (Case 6), and the pancreatic anastomoses were in good order at necropsy. Thus, it would appear from this small group that it would not be fair to condemn the end-to-end pancreaticojejunostomy and favor the end-to-side because it is likely that as more experience is obtained both methods will prove equally effective.

TABLE V. OPERATIVE MORTALITY IN RELATION TO DISPOSAL OF BILE DUCTS

OPERATIVE PROCEDURE	PATIENTS	HOSPITAL DEATHS	
		NUMBER	PER CENT
Choledochogastrostomy	1	0	0
Choledochogastrostomy and cholecystostomy	3	0	0
Choledochojejunostomy	11	2	18.2
Choledochojejunostomy and cholecystostomy	9	2	22.2
Cholecystojejunostomy or cholecystogastrostomy	5*	2	40.0
Choledochojejunostomy and cholecystojejunostomy	2	0	0
Cholecystectomy (incidental because of low insertion cystic duct)	3	-	-

*One patient required choledochojejunostomy as a secondary procedure for a biliary fistula.

In Table V are listed the various methods of disposal of the biliary system as related to the operative mortality. Choledochogastrostomy was used in four cases, with complementary cholecystostomy in three. Choledochojejunostomy was performed in twenty cases with complementary cholecystostomy in nine. Two patients had cholecystojejunostomy as a first-stage operation, but the surgeon in both instances elected to add, at the second stage of the operation, a choledochojejunstomy rather than tie the common duct for fear of leakage from the latter. Five patients had cholecystogastrostomy or cholecystojejunostomy and one of the latter required another operation for biliary fistula, at which time choledochojejunostomy was done. Recovery ensued. Including this case the common duct was utilized twenty-six times in the anastomosis with four deaths, a mortality rate of 15.4 per cent. The gall bladder was used five times with two deaths, a mortality of 40 per cent, and in one of these cases, as just mentioned, reoperation was required. Of the cases in which death occurred in the immediate postoperative period, cholecystojejunostomy was performed in two, Cases 1 and 2 (Table II). In only Case 2 at post-mortem examination was any evidence of leakage from the anastomosis of the gall bladder found. The tied end of the common duct did not leak in either case. In the other four cases in which death occurred in this series, Cases 3, 4, 5, and 6 (Table II), choledochojejunostomy was performed; no signs of leakage at the biliary anastomosis were exhibited either before death or in the three cases in which post-mortem examination was made.

In three patients in the entire series (10 per cent), the cystic duct was inserted so low in the common duct that it was severed with the common duct in carrying out the resection and of necessity the gall bladder was removed (Table V).

Although there is little evidence which clearly favors either anastomosis of the common duct or of the gall bladder and the latter group is too small for critical analysis, yet choledochojejunostomy seems to us the safer and more logical procedure of the two. If the common duct, however, is small, as it occasionally may be, then the gall bladder is more readily used for anastomosis and the duct, being small, is more safely ligated than when it is large and dilated.

In every case in this group jaundice completely disappeared after operation and only one biliary fistula developed. As yet there has been no cholangitis nor return of jaundice, except in those cases in which malignant obstruction of the ducts has recurred.

Gastrojejunal Anastomoses.—Seven different types of gastrojejunal anastomosis were used to re-establish gastrointestinal continuity (Table VI). To be certain there is no misunderstanding of our terms, a few words of definition are in order. In the isoperistaltic anastomosis the distal limb of jejunum is placed at the lesser curvature, whereas in the antiperistaltic it is placed at the greater curvature. The words "postcolic" and "supracolic" indicate that the loop of the jejunum is brought up behind the colon usually through the duodenal foramen; the gastrojejunostomy is performed above the mesocolon and the line of anastomosis is left there permanently.

TABLE VI. OPERATIVE MORTALITY IN RELATION TO METHOD OF RESTORATION OF GASTROINTESTINAL TRACT

METHOD	PATIENTS	HOSPITAL DEATHS	
		NUMBER	PER CENT
Antecolic, end-to-side, isoperistaltic gastrojejunostomy	10	3	30.0
Postcolic, antiperistaltic, end-to-side gastrojejunostomy	7	1	14.3
Postcolic and supracolic, end-to-side antiperistaltic gastrojejunostomy	5	0	0
Antecolic, end-to-side, antiperistaltic gastrojejunostomy	4	1	25.0
Pyloric end of stomach closed; postcolic, side-to-side, antiperistaltic gastrojejunostomy	2	0	0
Pyloric end of stomach closed; antecolic, side-to-side, isoperistaltic gastrojejunostomy	1	1	100.0
Postcolic and supracolic, end-to-end, isoperistaltic gastrojejunostomy	1	0	0

We would be presumptuous, on the basis of thirty cases, to try to settle the question of the best method of gastrojejunostomy, since there is no unanimity of opinion among surgeons on this question in spite of thousands of gastric resections performed for duodenal ulcer and gastric carcinoma in the past sixty years. Nevertheless, we cannot pass over some interesting data shown in Table VI without comment. The antecolic, end-to-side, isoperistaltic gastrojejunostomy was performed on ten patients with three deaths. Post-mortem

examination was done in two of these cases and there was no leakage at the anastomosis in either. In the third case leakage could have occurred, but since no post-mortem examination was permitted, this point has not been settled. The postcolic, antiperistaltic, end-to-side gastrojejunostomy was used seven times with one death, which resulted from coronary occlusion, and no leakage was found at necropsy. In four patients the antecolic, end-to-side, antiperistaltic gastrojejunostomy was chosen with one death, which was due to mesenteric thrombosis; leakage did not occur in this case. In the sixth case in which death occurred, separation and leakage of the gastrojejunal stoma was found at post-mortem examination; an antecolic, side-to-side, isoperistaltic gastrojejunostomy had been done with closure of the pyloric end of the stomach. Little of a definite nature can be drawn from this résumé concerning the selection of anastomosis, largely because the number of patients in each group is small and even more because probably the exact method is of secondary consideration to the diligence and judgment used in performing the anastomosis.

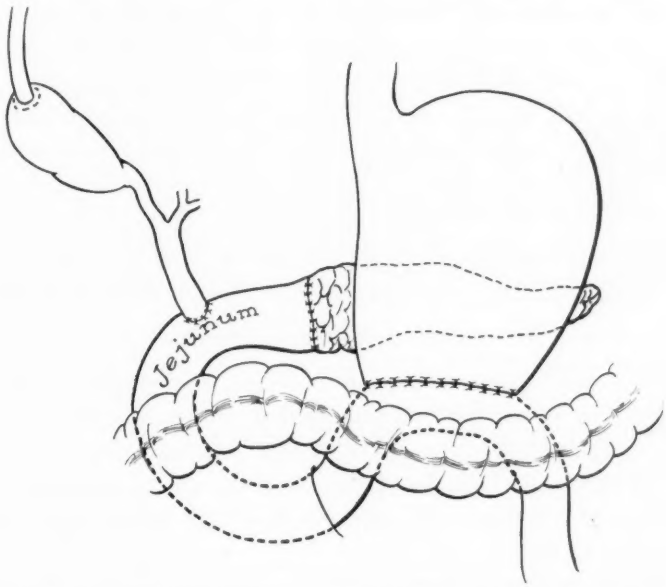

Fig. 1.—Technique for restoration of gastrointestinal tract, and biliary and pancreatic ducts following resection of duodenum and head of pancreas. (End-to-end pancreaticojejunostomy, end-to-side choledochojejunostomy, end-to-side, postcolic, antiperistaltic gastrojejunostomy.)

If data in Table VI are considered in another light, however, they may well be significant. Fifteen patients had antecolic anastomosis, with five deaths. In one of these cases leakage at the site of anastomosis definitely was present and in another it is possible that it occurred. The other three deaths were in no way related to the type of gastrojejunostomy performed. Fifteen patients had postcolic gastrojejunostomy, with one death due to coronary occlusion. These figures seem definitely to indicate that the postcolic anastomosis is more favorable. In twelve of the thirty cases an isoperistaltic gastrojejunostomy was used with four deaths, two from causes other than leakage at the site of anastomo-

sis, one definitely from leakage, and the other possibly from it. On the other hand, the antiperistaltic anastomosis was used eighteen times with two deaths, one from coronary occlusion, the other from mesenteric thrombosis; in neither of these cases was there evidence of leakage. If it is proper to draw any conclusions from this analysis, it would seem that the postcolic, antiperistaltic gastrojejunostomy is the procedure of choice.

ONE TECHNIQUE OF OPERATION

In Fig. 1 is shown a diagrammatic representation of the technique used by one of us (J. M. W.) on three patients,* which seems to be logical and certainly not contraindicated by the data in this paper. An end-to-end pancreaticojejunostomy is performed with end-to-side choledochojejunostomy 3 or 4 inches (7.6 or 10.2 cm.) distal to the pancreas, or wherever the common duct can readily be implanted without tension. A postcolic end-to-side antiperistaltic gastrojejunostomy is added, for which as short a proximal loop as is convenient is used. Care must be taken against possible tension on the two more proximal anastomoses. The root of the mesocolon is closed around the jejunum to prevent internal herniation. The gall bladder is drained as a safety measure to provide biliary drainage in case of temporary dysfunction of the choledochojejunal stoma. An end-to-end pancreaticojejunostomy is accomplished with facility more frequently than end-to-end choledochojejunostomy. This hookup more or less isolates the biliary and pancreatic systems so that food and the gastric juices are shunted distally, which may prove to be a factor in helping prevent cholangitis. Furthermore, if recurrence of the malignant lesion should supervene, it would not likely obstruct the gastroenteric stoma.

SUMMARY AND CONCLUSIONS

In thirty cases resection of the head of the pancreas and duodenum was performed for carcinoma in this region with an operative mortality of 20 per cent. The postoperative survival thus far on short follow-up is disappointing in the cases in which the operation was done for carcinoma of the head of the pancreas, but encouraging in those in which it was done for carcinoma of the ampulla of Vater.

Although the one-stage procedure is usually preferable, there is the occasional patient with severe damage to the liver, who will require a two-stage operation. Pancreaticojejunostomy, either end-to-end or end-to-side, has definitely improved the prospect for normal nutrition postoperatively. Choledochojejunostomy usually is preferable to cholecystojejunostomy in the one-stage procedure. Postcolic, antiperistaltic gastrojejunostomy made distal to the biliary and pancreatic anastomoses lends itself well to this type of resection and has proved most effective in the past in our hands.

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*The data of only one of these three cases is contained herein, as one resection was performed for calcification of the head of the pancreas with pain and the other, a resection for carcinoma of the ampulla, was done in February, 1946.

VALUE OF THE EXCLUSION OPERATION IN THE TREATMENT OF INTESTINAL FISTULAS

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CONFRONTED with certain acute lesions of the small intestine, such as segmental gangrene, it may seem apparent that exteriorization of the involved loop is the procedure of choice. Mitigating, however, against election of this procedure, even though recognized as most conducive to an early favorable prognosis, are the subsequent difficulties of management, principally (1) the continuous loss of intestinal content, which may lead to irreversible damage in spite of all methods of replacement therapy; (2) the distress of cutaneous excoriation adjacent to the open loops; and (3) the necessity of further procedures being carried out through a contaminated field.

Various nonoperative measures for the management of small intestinal fistulas, such as plugs, bridges, devices for skin protection, and tubal feeding, have proved to be only partially effective at best. While undergoing such forms of therapy the patient invariably loses ground to the extent that necessary further surgery is hazardous. Too often the situation culminates in death of the patient before definitive surgery is possible.

To obviate these grave sequelae and make feasible the procedure of exteriorization an operation is proposed, not new and yet not widely used, generally known as complete intestinal exclusion. This operation was described by Trendelenburg in 1885, and since then there have been occasional reports of its usefulness.

The prime objective of intestinal exclusion is the early restoration of intestinal continuity by an intra-abdominal anastomosis circumventing the fistula. The immediate restoration of the patient's economy consequent upon this procedure is a lifesaving feature not possessed by any other method of management of small intestinal fistulas. By use of the exclusion operation, the patient is regaining his health at a time when, if conservative measures were employed, he would be gradually losing ground. Concomitant with this lifesaving feature, intestinal exclusion provides definitive surgical care of intestinal fistulas in by-passing the fistulous segment, which by a relatively minor procedure may be removed then or later through clean, nonexcoriated skin.

The intestinal anastomosis should be effected within ten days of exteriorization if possible. In order that the appropriate loops be recognized within the abdomen at the time of exclusion, the use of catheters of unequal caliber in each loop is recommended. After identification the loops are transected and bowel continuity is re-established by anastomosis of afferent and efferent limbs. The open ends of the fistulous loops are inverted. In that the blood supply

Presented at the Third Annual Meeting of the Central Surgical Association, Chicago, Ill., Feb. 22-23, 1946.

Aided by the David May-Florence G. May Fund.

to the fistula is intact, it is the surgeon's choice whether the fistula be removed at the time or subsequently. One patient with whom I am acquainted, in whom the blind loops are plugging a hernia, has refused surgery for seven years following exclusion because of the little discomfort she is experiencing.

My attention was directed to the operation of intestinal exclusion by Dr. E. L. Keyes of St. Louis, who in 1941 reported a series of four cases. So gratifying were the results that several of his colleagues were influenced to use the procedure. At this time it is possible to report four personal cases in which the exclusion operation was performed, and to cite sixteen others done by various St. Louis surgeons.

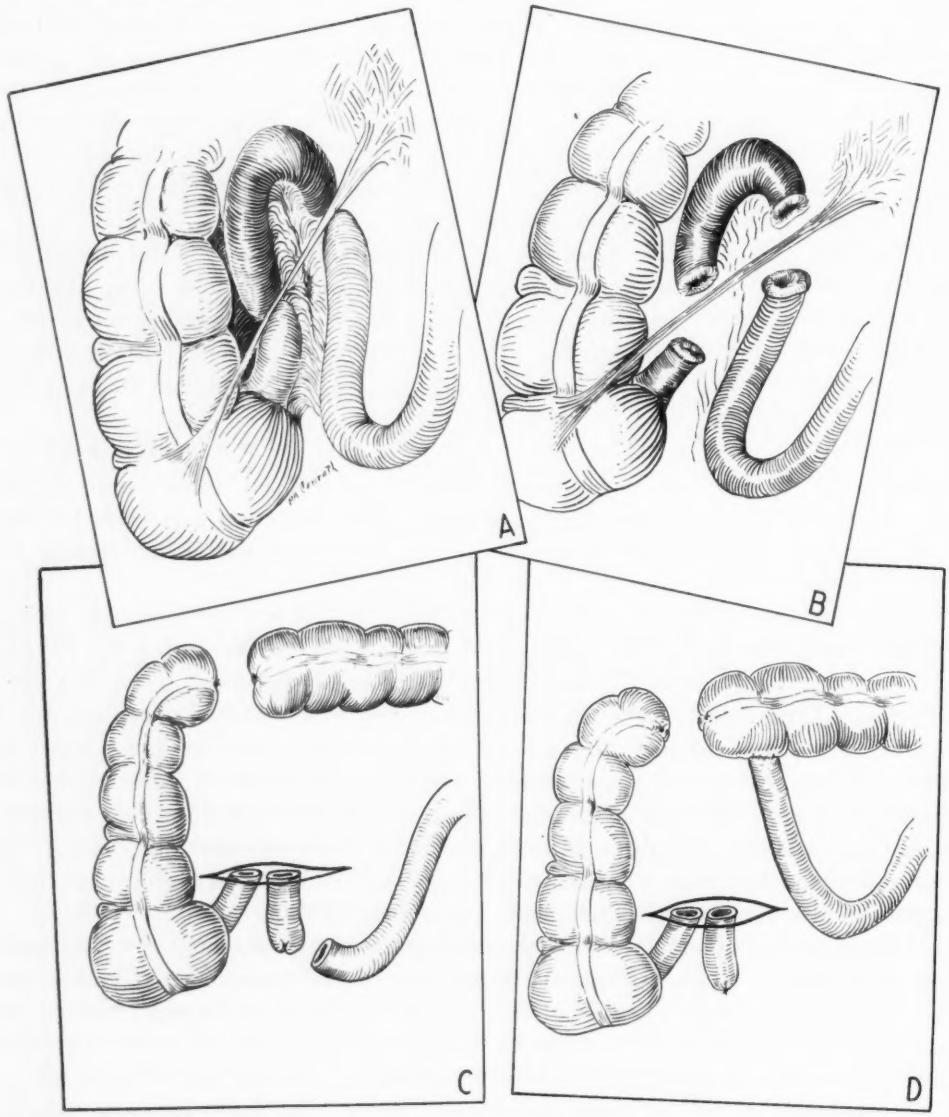

Fig. 1.—*A*, The fibrous band extending from the cecum to the posterior parietal peritoneum with the strangulated loop of gangrenous intestine. *B*, The self-transected loop of gangrenous intestine after manipulation of bowel. *C* and *D*, The excluded right bowel and proximal ileum and ileotransverse colostomy.

CASE REPORTS

CASE 1.—J. K., a 23-year-old woman, in the eighth month of pregnancy was admitted to the hospital on Oct. 20, 1942, complaining of intermittent, diffuse abdominal pain, radiating to the back, of two days' duration. Moderate nausea was associated; there had been no vomiting. An appendectomy had been performed elsewhere one year previously. While under observation in the hospital, the patient complained intermittently of the same symptoms. She had been seen by four physicians including the obstetrician, and the diagnoses ranged from psychoneurosis to uterine contractions. On the eighth hospital day she vomited a considerable amount of dark brown, thick fluid with a fecal odor. Then I first saw her and made a diagnosis of acute intestinal obstruction. Immediate laparotomy was advised and performed within a few hours. A gangrenous loop of ileum was found, 15 cm. in length, ex-

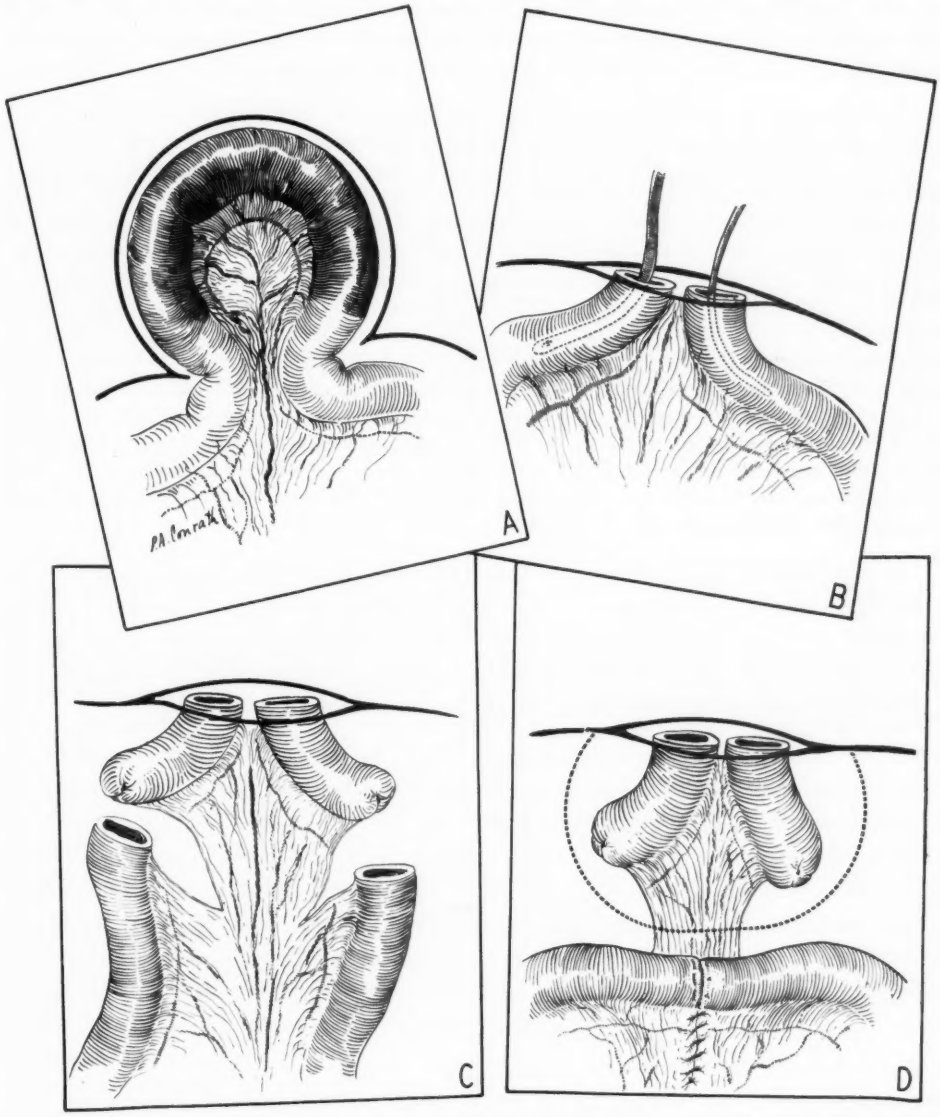

Fig. 2.—*A*, The gangrenous loop of strangulated intestine. *B*, The two open intestinal loops of small bowel with unequal catheters for identification of afferent and efferent loops. *C* and *D*, The excluded small intestine and anastomosis; the dotted line in *D* shows the blind segment of intestine to be removed subsequently.

tending within 3 cm. of the ileocecal valve; the ends of the loop had been completely severed by an adhesion which extended from the cecum to the parietal peritoneum, and feces were present free in the peritoneal cavity. The gangrenous loop was resected and the open ends of the ileum were exteriorized. On the following day the patient was delivered of an eight-month dead fetus; the incisional wound maintained its integrity. Because of peritonitis and partial renal insufficiency, her condition was critical. All usual methods for controlling small intestinal fistulas, including continuous suction, were employed for what I now feel was much too long a time, namely eight weeks. During this period the patient lost much weight and was failing rapidly. Consequently, on Dec. 12, 1942, the operation of complete exclusion was performed. Through a left rectus incision the proximal limb of the fistula was transected (Fig. 1), and ileotransverse colostomy performed. The fistula was excluded by closure of the blind ends of ileum and colon. Improvement was dramatic and prompt. Nutrition was restored almost immediately and the excluded fistula drained minimally. Eight months later the fistulous segment was removed, and the wound healed promptly. This patient was last seen three years later, on Jan. 1, 1946, and was well.

CASE 2.—M. G., a 70-year-old woman, was admitted to the hospital on Sept. 5, 1945, complaining of intermittent attacks of abdominal pain centering around an old cholecystectomy scar. Occasional vomiting was present. The past history was irrelevant except for cholecystectomy and appendectomy elsewhere several years previously. Examination revealed a mass about six inches in diameter in the lower end of the surgical incision. At surgical consultation, fourteen hours after admission, a diagnosis of acute intestinal obstruction secondary to strangulated incisional hernia was made, and immediate laparotomy advised. At operation three feet of gangrenous ileum were found in the hernia. The gangrenous bowel was resected, and the open loops of ileum were exteriorized. By the end of the second week, on Sept. 19, 1945, complete exclusion was performed through a left rectus incision. The limbs of the fistula were identified by previously placed catheters. The two loops were transected. Intestinal continuity was restored by end-to-end anastomosis of the interrupted ileum. The blind ends were closed and replaced in the abdomen. The patient withstood the operation well. The excluded segment was removed and the hernia repaired one month later, on Oct. 20, 1945. The patient was last seen three months later, on Jan. 15, 1946, at which time she was found to be well, and the wound healed.

In conclusion, it is my opinion that the most favorable immediate prognosis in certain cases of gangrene of the small intestine is offered by intestinal exteriorization. The complementary operation of intestinal exclusion is advocated in management of the resultant intestinal fistula, feeling that it is superior to all other methods of management, often to the extent of saving life.

RECONSTRUCTION OF WAR WOUNDS OF COLON AND RECTUM

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THIS paper is based upon the management and surgical reconstruction of all wounds of the colon and rectum operated upon at this center during World War II, namely, forty-three colostomies and five traumatic rectal fistulas in forty-one soldiers. As emphasized by Keene,[1] such casualties present more of a problem than the colostomies of civilian practice because the majority of them are complicated by associated battle injuries (see Table I) and because details of the colostomy constructed at the advanced surgical installations are usually scanty or lacking. The subject will be considered under the following headings: Overcoming Depletion, Closure of Colostomies, and Closure of Traumatic Rectal Fistulas.

OVERCOMING DEPLETION

Although chronic sepsis, such as osteomyelitis, associated intra-abdominal abscess or urinary or fecal fistula, was a minority occurrence in this group, most of the patients were fatigued and malnourished. Despite a preoperative build-up averaging twenty-five days, they came to surgery an average of 21.7 pounds below their best weight. The corrective regimen consisted of a high calorie, high carbohydrate and protein (120 to 150 Gm.) diet supplemented by three multivitamin capsules a day. Those responding poorly to this received, in addition, amino acids* both in powder form by mouth and in 5 per cent solution by vein.[2, 3] This relatively new form of protein alimentation is of outstanding value in hastening the restoration of depleted and debilitated patients and in maintaining nutrition in those temporarily denied oral intake. Each liter flask of intravenous solution, of which two or even three may be administered each day, contains 50 Gm. of glucose and the equivalent of one-half pound of lean beef. Unfortunately, nearly half of our patients could not take the powder by mouth for more than two or three days before developing anorexia and/or diarrhea. One soldier tolerating it well gained sixteen pounds in fifteen days. The weight of another soldier on the usual high calorie, high vitamin diet at another general hospital in this country stayed at 109 pounds (his normal weight was 155 pounds), but after twelve days in this hospital on the amino acid powder supplement, he gained nine pounds. During the following twelve days without the powder, he gained only three more pounds. A third soldier, unable to take the powder and showing no increase in weight on his diet, gained seven pounds in six days upon the addition of one liter a day of intravenous amino acids.

Presented at the Third Annual Meeting of the Central Surgical Association, Chicago, Ill., Feb. 22-23, 1946.

*The product here used is marketed by Mead Johnson under the trade name of "Amigen." This is an acid hydrolysate of casein and pork pancreas, containing all the essential amino acids.

TABLE I. INJURIES AND COMPLICATIONS ASSOCIATED WITH COLOSTOMIES

INJURY	NUMBER
Perforating chest wounds	4
Compound fractures	
Pelvic bones	14
Shaft of femur	1
Lesser trochanter of femur	1
Lumbar transverse process	1
Osteomyelitis of pelvic bones still present	10
Lacerations of gastrointestinal tract	
Stomach	2
Jejunum	4
Ileum	8
Colon or rectum	39
Resection of left colon	1
Resection and anastomosis of small bowel	4
Intra-abdominal abscess still present	4
Fistulas other than colostomy still present	
Gastric	1
Jejunocolic	1
Colic or rectal	7
Urinary	3
Laceration of spleen	1
Laceration of kidney	1
Laceration of bladder	5
Bilateral nephrolithiasis and bilateral nephrostomy	1
Laceration of iliac or femoral veins	2
Femoral nerve paralysis	2

Patients with even mild anemia received blood transfusions so that with two or three exceptions they all showed at time of operation a red cell count of at least 4,250,000 and hemoglobin of over 80 per cent. Their total protein determinations ranged within normal limits.

CLOSURE OF COLOSTOMIES

The colostomies had originally been performed overseas, either to exteriorize a laceration itself or to divert the fecal stream from a wounded segment that could not be mobilized. Their locations were as shown in Table II.

TABLE II. LOCATION OF COLOSTOMIES

LOCATION	NUMBER
Cecum	3
Ascending colon	1
Hepatic flexure	1
Transverse colon	7
Splenic flexure	3
Descending colon	4
Sigmoid	24

Seven of the colostomies in this series were closed before the present study was begun. Of these, five were closed by the extraperitoneal method. The other two, together with the thirty-six remaining closures done by us or with our assistance, were all intraperitoneal and form the chief basis for our remarks. In five of the forty-three colostomies it was necessary to perform an end-to-end anastomosis. In three of these the two limbs had been previously completely severed. In one patient the left colon had been resected, the functioning transverse stoma had been brought out in the left flank, and the sigmoid

stoma had been implanted in the left groin. Here, after the two limbs had been dissected free, they were anastomosed end-to-end, without an attempt to approximate their widely retracted mesenteries. The fifth patient (Case 1) is reported upon later.

Preoperative and Postoperative Care.—Preoperative diagnostic studies included a barium enema of the distal colonic loop in all cases, small bowel studies if obstruction or other derangement of small bowel was suspected, and lipiodol studies of all sinuses and fistulas. In this manner four abnormal sinuses or fistulas were disclosed that might otherwise have been overlooked.

In thirty-five of the thirty-six colostomies closed by us, including four of the end-to-end anastomoses, a modification of the sulfasuxidine routine of Poth and Knotts[4] was employed. For at least five days immediately preceding operation each patient received by mouth 12 Gm. of the sulfonamide in divided daily doses, and another 2 Gm. suspended in 2 ounces of water was instilled in the distal loop of the colostomy. The drug was continued postoperatively only in one case. No laxative was used. Proximal and distal colostomy loops were irrigated once with tap water the night before operation.

Three to five grams of sulfanilimide crystals were applied locally at the time of operation. Twenty-one patients in the entire series were given three hourly intramuscular injections of 25,000 to 40,000 units of penicillin for the first few postoperative days, while seventeen other patients received, instead, postoperative sulfadiazine therapy, first by vein and then by mouth, 1 Gm. every four hours.

Although some authorities[5, 6] feel that sulfonamides are needless in colon surgery, Dickson and Benson[7] have presented strong statistical evidence in favor of these agents, especially sulfasuxidine, and a number of others[1, 8–11] also favor their use.

From the previous experience of one of us (J. E. H.) with sulfasuxidine in over twenty colon operations with one wound infection and with one fatality from general peritonitis following an abdominoperineal resection of a huge advanced carcinoma of the rectum, we had come to place such confidence in the drug that we did not withhold it from any of these patients. Thus, our only basis for comparative evaluation is between our thirty-five operations in which it was used and the preceding seven colostomy closures in which no sulfasuxidine or a very inadequate amount was used. The results are tabulated in Table III.

Wounds indicated in Table III as having temporary drainage all proceeded to essentially per primam healing. It is interesting that one of the two patients without sulfasuxidine prophylaxis, who developed wound infection, had undergone an end-to-end anastomosis of the transverse colon while receiving 20,000 units of penicillin every three hours. He developed both a wound sepsis and an intraperitoneal abscess. No patient in either group developed peritonitis.

TABLE III. RESULTS IN OPERATIONS WITH AND WITHOUT SULFASUXIDINE

	WOUND INFECTIONS	TEMPORARY DRAINAGE	PER PRIMAM HEALING	TOTAL
With sulfasuxidine	1	3	31	35
Without sulfasuxidine	2	1	5	8

No significant difference was noted between the twenty-one patients who received penicillin postoperatively and those who received sulfadiazine.

In the thirty-four patients receiving sulfasuxidine, wound healing was complete within a 10.4 day average. These patients were allowed out of bed in an average of 10.5 days. Data are not available concerning those not receiving the drug.

Adequate decompression postoperatively was attained by routine anal dilatation and the passage of a Levine tube to which Wangensteen suction was applied until the patient started to pass gas by rectum, usually within thirty to seventy-two hours.

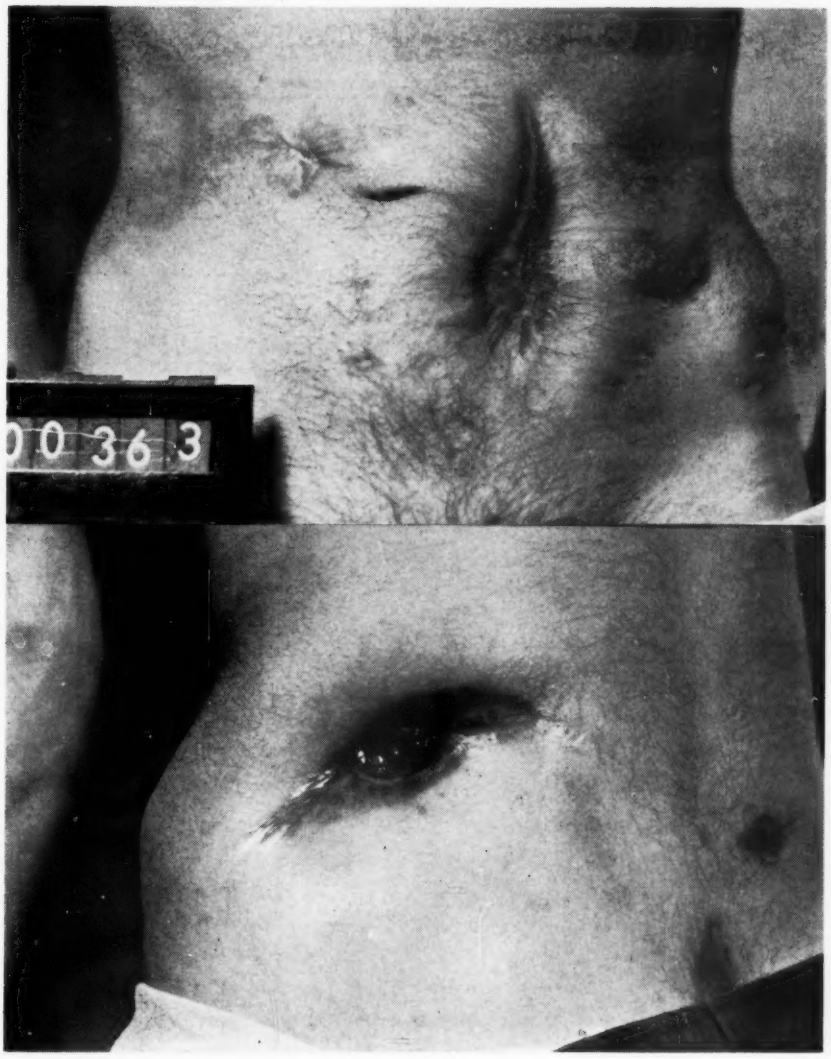
During or immediately after operation most patients received 500 to 1,000 c.c. plasma and, if necessary, one pint of blood. Thereafter, hydration and nutrition were maintained by one or two liters each of amino acid solution and of 5 per cent glucose in normal saline solution.

Intraperitoneal Closure.—Intraperitoneal closure of colostomies and open end-to-end suture for anastomoses were used exclusively in the thirty-six operations performed by the authors and in two of the seven previously closed colostomies. With sharp dissection and "silk technique" all adventitious scar tissue and skin were trimmed away from the openings of the stomata and the two colonic limbs were inspected without breaking up an unnecessary number of the local adhesions. A transverse closure was then carried out with an inner continuous suture of fine chromic gut, taking all layers and an outer inverting row of interrupted Cushing stitches of fine cotton, in which pains were taken to include the submucosa. Where the two limbs of the colostomy were fused at their mesenteric borders, this fusion was left undisturbed as a valuable buttress to the closure. Any disparity between the two bowel loops was corrected by incising backward from the mouth of the smaller limb along its antimesenteric border and rounding off the corners thus formed. Although in a few cases at operation the lumen at the point of closure seemed rather small, none of our patients has shown any evidence of colonic obstruction or disturbance of bowel movements. Of all the thirty-eight intraperitoneal closures, five with end-to-end anastomoses, none has broken down or obstructed. In one case (Case 1) a small fistula, at first fecal and later mucus, developed, but this completely healed, as proved by barium enema on the ninetieth postoperative day.

Whether or not to crush the colostomy spur is still a moot point. Rankin and Graham,[13] Clute,[14] Dickson and Benson,[7] and Fitzgerald[15] practice it, while Coller and Vaughn,[9] Keene,[1] and others have abandoned it. We discontinued spur crushing at the start of this series because it seemed unnecessary, because it was disagreeable or actually painful to the patient, and because of the meager information available concerning the original colostomy construction. One of our patients whose colostomy spur had been crushed overseas had, as a result, a jejunocolic fistula. In several other patients with distortion or rotation of the two component colostomy loops, spur crushing would have endangered the blood supply.

The abdomen was closed in most cases in layers with cotton and silk, although a few of the wounds were closed with through-and-through No. 32 steel wire. Occasionally a small rubber drain was placed to peritoneum or fascia. Delayed closure of skin and subcutaneous tissue as described by Coller

A.



B.

Fig. 1 (Case 1).—Photographs taken Aug. 13, 1945, forty-seven days after arrival at this hospital. Note the imperfect colostomy stoma. The posterior fistulous wound has decreased in size since the patient's entry.

and Valk[12] was not employed, the wounds nearly all healing per primam much in the manner of a clean McBurney incision.

CASE REPORT

CASE 1.—On April 17, 1945, in action against the enemy in Germany, a 23-year-old soldier was wounded by a shell fragment which fractured the left posterior iliac wing,

lacerated the sigmoid colon and ileum, and severed the left femoral nerve. Two or three hours later a segment of ileum was resected and the sigmoid laceration was exteriorized as a loop sigmoidostomy.

The soldier arrived at Crile General Hospital on June 27, moderately septic, thirty-three pounds underweight, with a functioning sigmoidostomy, active osteomyelitis of the left iliac wing from which two large sequestra were extracted the day of arrival, and a fecal fistula leading through the osteomyelitic iliac wing into the proximal sigmoidostomy limb (Fig. 1). A lipiodol and barium study demonstrated the fecal fistula (Fig. 2). After forty-two days of preparation the patient's weight had increased from 130 to 139 pounds and the posterior wound became cleaner and much smaller, although still draining feces. Following the usual preliminary sulfasuxidine therapy, colostomy closure was performed on August 8.

Fig. 2 (Case 1).—Barium enema, showing the lateral extension of the abscess pocket resting on the concavity of the left iliac wing and the fecal fistula opening posteriorly between the two arrows.

The operation proved formidable. It was found that the proximal stoma opened partly to the surface and partly into a small abscess cavity which rested upon the concavity of the left iliac wing, through which the fecal fistula made its exit posteriorly. The distal colostomy loop was distorted and stenosed beyond use to its point of entry into the true pelvis. Freeing the proximal limb from the abscess unavoidably allowed a moderate spillage of feces into the wound and its was necessary to resect several inches from both colostomy

limbs. The end-to-end anastomosis of the bowel was rendered hazardous because of the wound contamination, because in spite of mobilization of the descending colon from the splenic flexure down, the anastomosis was performed under slight tension, and because the distal segment was narrow and thick-walled and had a rather poor blood supply. Utilizing the plastic procedure already described to widen the distal stoma, the two ends were accommodated to each other and closed in two layers. Due to the precariousness of the closure, one Penrose drain was brought out through the main incision and the other posteriorly through the former fecal fistulous track. One hundred thousand units of penicillin were instilled into the abdominal cavity and three hourly intramuscular injections of 60,000 units were started. A total of 7,840,000 units was given.

The patient had a surprisingly smooth preoperative course. He started to pass gas in forty-eight hours and the bowels began to move the sixth postoperative day. The abdominal incision, in spite of the drain which was removed the fourth day, had healed per primam by the tenth day. There was moderate fecal leakage through the previous posterior fecal fistula from the eighth to the seventeenth postoperative days. Following this there was a gradually diminishing, slightly mucoid drainage, until final healing ninety days after operation. A checkup barium enema at this time revealed an intact anastomosis. The patient, aside from the left femoral nerve paralysis, is entirely symptom free, the bowels move normally, and weight has remained at about 138 pounds.

Extraperitoneal Closure.—It is instructive to contrast the eight closures by the extraperitoneal method with the intraperitoneal method just described. These eight extraperitoneal cases include three in which unsuccessful closure was performed overseas upon colostomies which we later successfully closed intraperitoneally; the remaining five colostomies were closed in this hospital prior to the adoption of the intraperitoneal techniques. Locations of stomata were as shown in Table IV.

TABLE IV. LOCATION OF STOMATA

LOCATION	NUMBER
Transverse	1
Splenic flexure	2
Descending colon	1
Sigmoid	4

Recurrence of fecal fistula with failure of closure resulted in three patients, in one of whom closure had been twice attempted. Three patients developed intestinal obstruction, one of whom died as a result. The stoma in the second, after prolonged fecal drainage, finally closed. In the third, opening the wound around the closed stoma sufficiently relieved the obstruction and healing occurred by granulation. One other patient died an unexplained and apparently unrelated death on the fourth postoperative day, autopsy revealing an adequate channel past the point of closure.

This poor showing, seven complications or failures out of eight extraperitoneal closures, is not presented as a general condemnation of the method in all situations. Before the introduction of sulfonamides and of protein and vitamin replacement therapy, extraperitoneal closure was probably the most generally accepted method, avoiding the hazards of peritoneal soiling.[13, 14, 16] From another army hospital, Pilcher and Nadeau[17] have presented a satisfactory technique for extraperitoneal colostomy closure which was completely success-

ful in their hands in thirteen out of fifteen instances. In our experience, however, the intraperitoneal closure appears to be safer and far more satisfactory than the extraperitoneal.

CLOSURE OF TRAUMATIC RECTAL FISTULAS

Our experience consists of six traumatic rectal fistulas, five in the present hospital series and one operated upon by one of us (J. E. H.) at another hospital, but in a similar manner. In all cases the internal opening of the fistula could be palpated by doing a digital examination of the rectum. In one patient the missile entered just above the symphysis and passed through the bladder and rectum and out through the lower sacrum; in another it entered through the right groin and passed out through the coccyx; in three patients it entered through the buttocks or lower sacrum; in the sixth the exact site of entry is forgotten.

The seriousness of these innocent-appearing little fistulas, usually opening in the sacrococcygeal region, may be underestimated to the extent that closure may be attempted merely by freshening the borders and taking a few deep through-and-through sutures. Actually, it will usually be found that from one-quarter to one-half of the rectal circumference is replaced by dense non-epithelized scar tissue, sometimes associated with an abscess pocket. In addition, three of our patients had moderately severe rectal stricture at the site of injury. There is also a marked tendency to recurrence of these fistulas. In one patient (Case 2) in whom closure was evidently by mass suture overseas, the external opening was closed, but an internal sinus persisted connecting the rectum with a pocket containing a large shell fragment. In a second, closure had been attempted once unsuccessfully before we closed it, and a third patient had been operated upon three times (once by ourselves) with recurrence before we finally succeeded in the closure.

Technical Details.—The general pre- and postoperative care was the same as for the colostomy closures, except that since the fecal stream was completely or nearly completely diverted by the sigmoidostomy, oral sulfasuxidine was usually omitted.

The first prerequisite for a successful closure is exclusion of feces from the field. In the patient with three recurrences, the first closure had been attempted in the presence of a partially functioning rectum. Not only did the closure fail, but severe cellulitis of the perirectal and gluteal tissues developed.

Adequate exposure will require a generous incision and the removal of the coccyx and the fifth, and sometimes the fourth, sacral segment. The rectum itself is reached after dividing an extremely dense, thick and scarred fascia propria. The rectal wall itself must be gently peeled away from the sclerosed enveloping tissues for some distance around the fistulous opening to allow closure free of tension. Stenosis must be looked for and, if found, corrected as in a pyloroplasty, by longitudinal incisions into the wall away from the fistula and then a transverse closure. We have employed for this a double tier

Fig. 3 (Case 2).—Photograph shows healed shell fragment entry wound in left buttock.

Fig. 4 (Case 2).—Barium enema with small outpouching on the right extending toward the shell fragment.

of fine interrupted cotton, the inner one through-and-through and the outer one inverting. A third layer of closure may sometimes be made of the scarred fascia propria. Except in one case, complete wound closure was impossible because the mobilization required had caused the rectum and its adjacent tissues to prolapse away from the sacrum, producing dead space which could not be obliterated. Final healing, therefore, was by granulation. All fistulas were successfully closed, although as previously mentioned, there was a preliminary failure in one case. Case 2, which follows, presented a problem as to whether a sinus track still persisted between the rectum and the abscess pocket containing the piece of steel. Closure of the sigmoidostomy before the ablation of the sinus would undoubtedly have resulted in a serious perirectal abscess necessitating reconstruction of the sigmoidostomy.

Fig. 5 (Case 2).—Repeat barium enema with faint trickle of barium proving the presence of a traumatic sinus extending to the right to enclose the shell fragment.

CASE REPORT

CASE 2.—A 23-year-old soldier received a left gluteal wound from an enemy shell fragment in Germany, Nov. 25, 1944. The missile fractured the fifth sacral segment, perforated the rectum, and lodged in the tissues to the right of the latter. Wound débridement and loop sigmoidostomy were performed fourteen hours later and a total of 1,440,000 units of penicillin was injected intramuscularly. On December 6, following several severe

hemorrhages from the rectum and posterior wound, his record indicated "suture of rectal defects, packing of rectum and wound." The technique of this suture was not given.

The soldier arrived at this hospital March 3, 1945, with a defunctionalizing sigmoidostomy and with a healed left gluteal wound (Fig. 3). Digital examination and probing through a sigmoidoscope failed to reveal whether a track still persisted from the dimple in the right rectal wall, shown by the first barium enema, out to the steel fragment (Fig 4). A repeat study, revealing a trickle of barium out and around the fragment, confirmed our suspicions (Fig. 5).

On March 26, through a posterior approach and in the manner already described, the rectal sinus was closed and the foreign body and its abscess pocket removed. Marked stricturing at the site of injury was corrected, also as described, by longitudinal incisions in the two rectal segments and a transverse closure of the bowel wall. The partially closed wound was allowed to heal by granulation and on April 30 the sigmoidostomy was closed by our routine intraperitoneal method. A final minor plastic operation was performed on August 2 for the removal of the thick sacral scar.

SUMMARY

1. A report of closure of forty-three colostomies and six traumatic rectal fistulas in forty-one patients with war wounds of colon and rectum is presented.

2. Complete success followed in all thirty-six intraperitoneal colostomy closures, including five end-to-end anastomoses, although in one a tiny mucous fistula persisted for ninety days. Of eight extraperitoneal closures (three done overseas), three failed and three developed intestinal obstruction.

3. Of thirty-five colostomy closures pretreated with sulfasuxidine, thirty-four healed per primam and one developed a wound infection. Two wound infections, including one intraperitoneal abscess, occurred among eight colostomy closures unprotected by sulfasuxidine.

4. Crushing of the colostomy spur is deemed unnecessary. It is actually dangerous in colostomies performed overseas since, due to inadequate data as to their construction, a crushing clamp might cut off the mesenteric blood supply or catch a loop of small bowel.

5. In closure of traumatic rectal fistulas the importance of preliminary complete diversion of the fecal stream and of wide mobilization of the rectal wall itself to allow closure without tension is stressed.

6. The oustanding value of amino acid mixtures, especially for intravenous alimentation, is emphasized.

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TRANSVERSE COLOSTOMY

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INTRODUCTION

DESPITE the very definite trend toward one-stage operations for resection of the colon, there is still a definite field for multiple-stage procedures. Obstruction of the colon, either acute or subacute, is a clear contraindication to resection and primary anastomosis. Decompression should be the limit of surgical intervention in the presence of obstructive manifestations. Obstruction of the right colon usually can be alleviated by the Miller-Abbott tube, but obstructive lesions of the left colon and rectum require operation. Appendectomy and cecostomy achieve satisfactory decompression, but both decompression and defunctionalization can be attained only by transverse colostomy. The advantages of defunctionalization have been emphasized by Devine,[1] but the method that he outlines is an unnecessarily complicated procedure. The same result may be obtained by a simple loop colostomy, an operation that can be performed satisfactorily under local anesthesia. Devine's suggestion of utilizing the right half of the transverse colon as the temporary colostomy site in lesions of the left colon has received almost universal acceptance. Wangensteen,[2] Dennis,[3] Heyd,[4] among others, enthusiastically endorsed this principle.

Appendicostomy is the ideal method of producing decompression of the colon in a sick patient. Under local infiltration anesthesia a small McBurney muscle-splitting incision is made. If on opening the peritoneum, a freely movable appendix is seen, it is easily delivered into the wound, and the operation is over. Unhappily, distention of the cecum obscures the appendix in the great majority of instances so that the operation is rarely feasible. Cecostomy too, in the presence of complete obstruction and a distended cecum, is a difficult and dangerous procedure. Exteriorization of an intact segment of the cecal wall is often impossible and deflation practically always is accomplished at the expense of some soiling. Wangensteen[2] reported a 50 per cent mortality, and Coller and Ransom[5] recorded the loss of five out of seven patients on whom cecostomy was done for total obstruction.

The uncertainties of appendicostomy and the hazards of cecostomy can be circumvented by utilizing the transverse colon as the site for decompression. Moreover, colostomy in the transverse colon produces not only decompression, but defunctionalization as well. The transverse colon is well suited for the performance of colostomy, since it is the most mobile, the narrowest, and the least distensible portion of the colon. Furthermore, if the right half is used, the colostomy is then located well away from any incisions planned for operative procedure on the left colon. Left subcostal, left rectus, transverse at the umbilicus, and the Cherney[6] modification of the Pfannenstiel incisions can all be planned and executed through uncontaminated areas.

Presented at the Third Annual Meeting of the Central Surgical Association, Chicago, Ill., Feb. 22-23, 1946.

INDICATIONS

1. As an alternative to cecostomy or appendicostomy in decompression of an obstructed left colon or rectum.

2. To produce defunctionalization of the left colon as a preliminary step in multiple-stage resections.

3. To complement primary resection of left colon.

OBJECTIONS

1. A second operation is always necessary for closure. Only appendicostomy and tube cecostomy close spontaneously. The partially exteriorized cecum always requires an operative closure only slightly less time consuming or hazardous than the closure of a transverse colostomy.

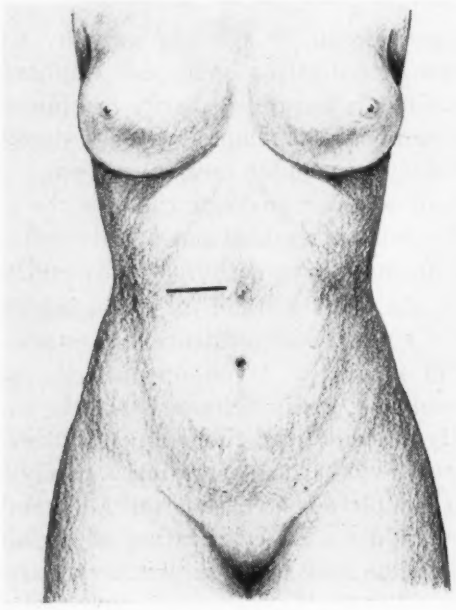

Fig. 1.—Incision four inches in length midway between umbilicus and tip of sternum.

2. Defunctionalization may not be as complete as with the Devine operation. It is true that the proximity of the two openings in the colon often allows the passage of some fecal material from the proximal to the distal, but this is minimal if the bowel is completely sectioned as it should be, and in any event the amount is so small that it constitutes only a theoretic disadvantage.

3. No exploration of the abdomen is possible, particularly when the colostomy is done as the first stage of a proposed graded resection. This may prove to be a disadvantage if at the next operation the tumor proves to be unresectable, but no great harm has been done, for the patient already has a satisfactory colostomy. These occasional cases will be more than offset by the number of tumors that are rendered resectable by defunctionalization of the colon. Certain lesions apparently inoperable from fixation by inflammation

reaction may become operable when the inflammation subsides following diversion of the fecal current.

OPERATIVE TECHNIQUE

Anesthesia.—The operation can always be done under local infiltration anesthesia supplemented by nerve block and injection into the mesocolon. Occasionally the surrounding extraperitoneal tissues require anesthetization, if for any reason delivery of the colon is difficult. Preliminary sedation with seconal, 3 gr., and morphine, ⅙ gr., is helpful.

Incision.—A short transverse incision 3½ to 4 inches long is made over the right rectus muscle, midway between the umbilicus and tip of the xiphoid cartilage (Fig. 1). The medial extremity of the incision extends to the linea alba. As the incision is deepened, the belly of the right rectus muscle is cut across its fibers (Fig. 2) exposing the posterior rectus sheath, the fibers of which are separated, and the peritoneum opened in the same line.

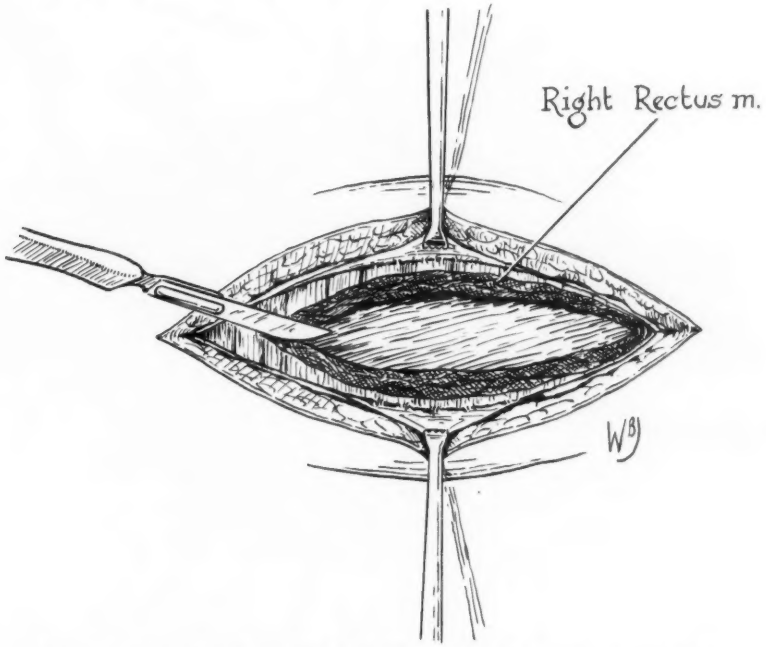

Fig. 2.—Right rectus muscle and its sheath sectioned transversely.

Delivery of the Colon.—In spare subjects the transverse colon is seen shining through the thin layers of the great omentum (Fig. 3). This structure is then separated from the colon along the line of its bloodless embryonic fusion, and the underlying segment of colon is gently teased through the incision (Fig. 4). An opening is made in the mesocolon with a blunt forcep, and a short glass or plastic rod is thrust through the aperture. The ends of the rod are enveloped by a looped section of rubber tubing which prevents slipping when the rod comes to rest on the skin surface (Fig. 5). When there is pronounced distention, delivery of the colon will be facilitated by pulling out the great omentum and leaving it attached to act as a tractor until the

segment is exteriorized. Likewise, in obese patients where fat deposits obscure the exact location of the colon, traction on the intact omentum will aid in its identification and extrusion. Once the colon is out the omentum can be detached, split transversely, and returned to the abdominal cavity. When dealing with distended gut, great care must be exercised in opening the mesocolon preparatory to passage of the glass rod, for the thin-walled intestine is easily damaged. Fixation of the colon or omentum from previous inflammatory reactions or operations produces the only real difficulty that I have encoun-

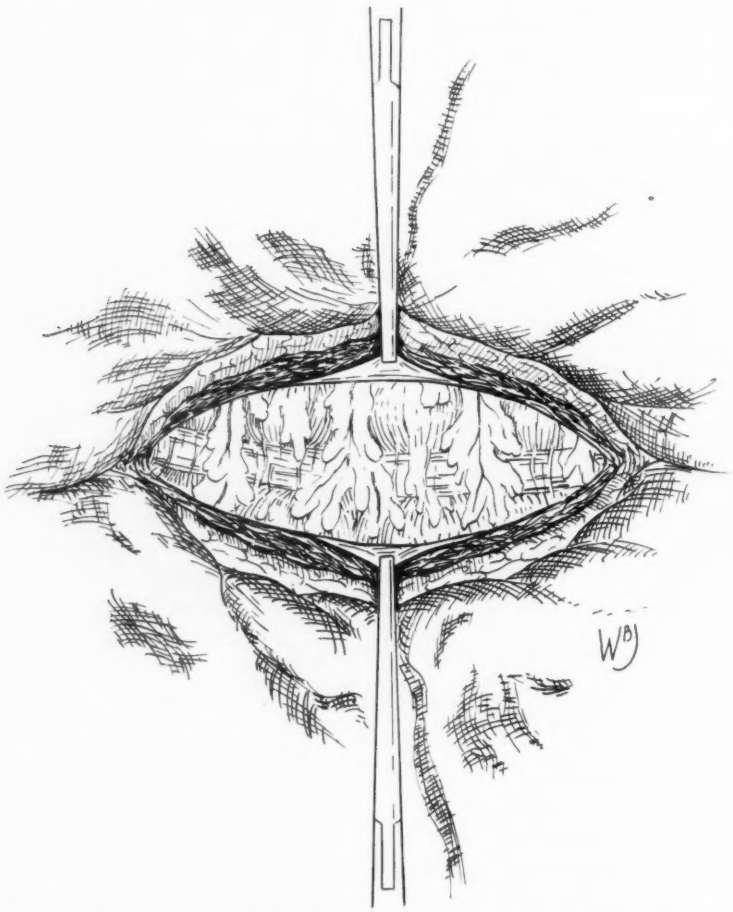

Fig. 3.—Upper and lower margin of posterior rectus sheath grasped with Kocher clamps and separated to expose right transverse colon.

tered. However, patience plus liberal infiltration of the extraperitoneal tissues and the mesocolon will always reward persistence. The extruded segment of intestine fills the opening almost completely since the round ligament of the liver lies flush with the distal limb.

Closure of the Wound.—A single figure-of-eight nonabsorbable suture closes the linea alba and medial extremity of the severed rectus sheath, and the skin margins are approximated about the bowel with fine silk or tantalum wire

sutures, but no stitches attach the bowel to any of the layers of the abdominal wall. A strip of dry one-inch gauze packing tucked in between the bowel and skin margin promotes early sealing off and adhesion between the two structures.

AFTERCARE

Deflation of the distended bowel is accomplished a few hours later by inserting a size 18 needle into the dome of the delivered intestine, but opening of the bowel is delayed for twelve hours at which time the wound is sufficiently healed to avoid infection. The opening which extends through most of the antimesenteric circumference is made at right angles to the long axis of

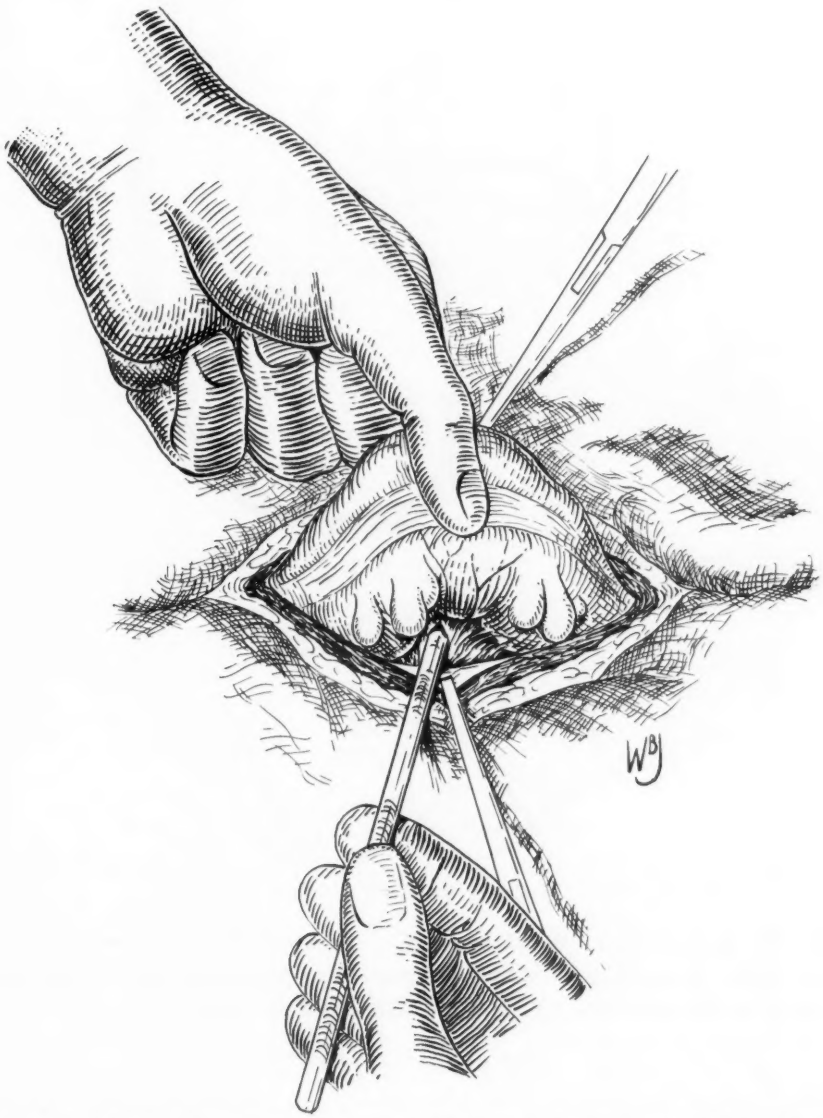

Fig. 4.—Colon elevated into wound and held in place by glass or plastic rod thrust through its mesentery.

the bowel. Failure of the colostomy to function is due to ileus which usually responds to stimulation with prostigmine, followed by cottonseed oil instillations and saline irrigations. When normal bowel function is restored and the patient's general condition permits, irrigation of the distal segment should be commenced. This accomplishes cleansing of the colon and reduction in the inflammatory elements of the tumor mass. At the end of two weeks the mesen-

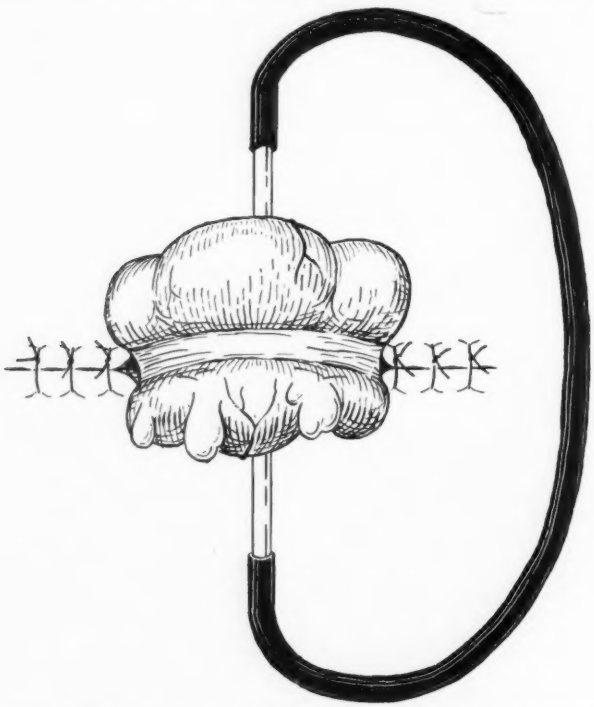

Fig. 5.—Skin closed and ends of glass rod protected by rubber tubing; no sutures are inserted into the bowel wall.

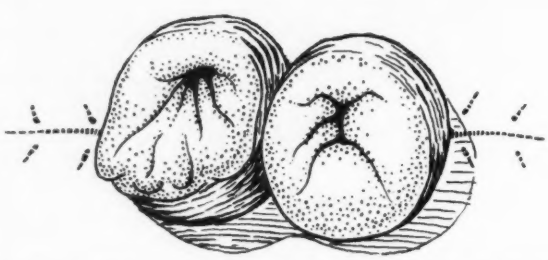

Fig. 6.—Bowel completely sectioned in ten to fourteen days.

teric border of the bowel is cut through with a cautery, and the glass rod is removed (Fig. 6). This division separates the proximal and distal opening sufficiently to effect almost complete diversion of the fecal stream.

CLOSURE OF COLOSTOMY

Resection of the tumor is usually carried out two weeks after fashioning the colostomy, but closure of the colostomy is best delayed until two months

have elapsed from the time of the primary operation. Allowing two weeks between stages and two weeks' hospitalization after resection, this means that the average patient returns in one month for closure of the colostomy. Closure is best effected by intraperitoneal end-to-end open anastomosis, since this avoids both the preparation of a double-barreled loop, and the time-consuming multiple spur crushing of the extraperitoneal closure. Coaptation of the wound is facilitated by a relaxing transverse incision through the rectus sheath above and below the opening (Fig. 7). Since adopting this method, we have had no failure or delay in bowel healing, and no patient has developed peritonitis.

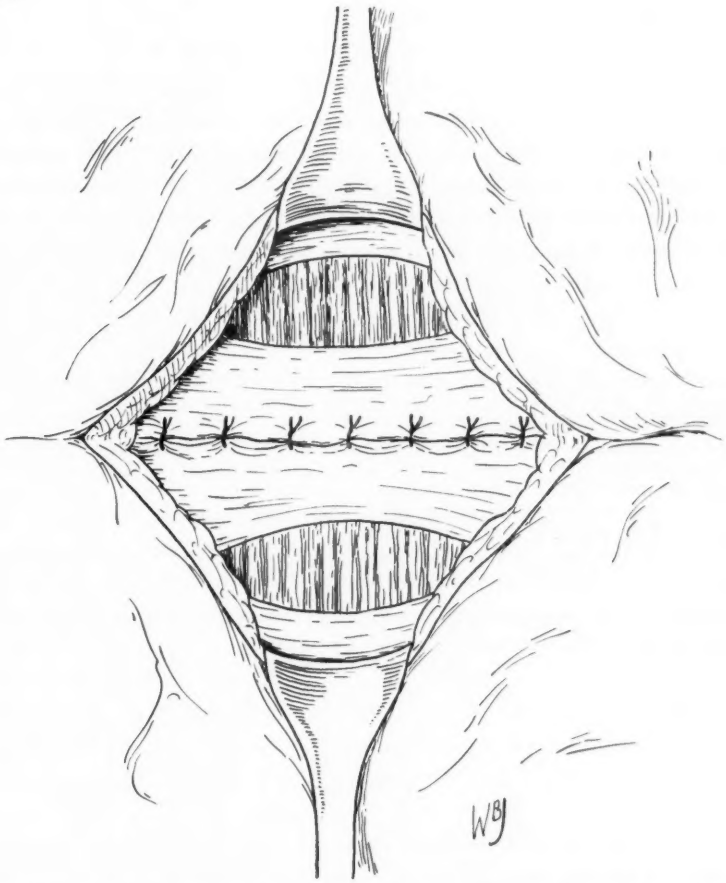

Fig. 7.—Colostomy closed by end-to-end suture; wound closure facilitated by relaxing incisions in rectus sheath.

EXPERIENCE WITH THE OPERATION

During the past ten years, February, 1936, to February, 1946, we have performed this operation seventy-eight times. Of these, sixty-two were done to relieve acute obstruction of the left colon. Two patients died before resection, one from pulmonary embolism on the third postoperative day and one from uremia on the fifth postoperative day. There were no deaths due to the procedure itself.

COMMENT

The use of local anesthesia is a distinct advantage to the patient, for a very sick patient with obstruction can be relieved with a minimum amount of disturbance. Similarly, the patients facing a series of operations are not subjected to the dangers inherent in a major operative procedure and are thus in a better condition to withstand the resection which necessarily is an operation of some magnitude.

The transverse incision permits the extrusion of distended bowel, which would be impossible to deliver if a vertical incision was used, because twisting of the bowel in its axis is unnecessary.

Prevention of retraction of the bowel by a glass or plastic rod obviates the necessity for suturing the bowel to any of the layers of the abdominal wall. This is of utmost importance, for sutures introduced into distended bowel invite infection, regardless of how carefully they are inserted. Complete section of the lumen of the extruded bowel prevents overflow filling of the distal segment, thereby confining all the benefit of the Devine exclusion.

Mobility of the transverse colon allows end-to-end closure of the colostomy and elimination of spur formation and spur crushing.

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RADICAL PERINEAL PROSTATECTOMY FOR CARCINOMA OF PROSTATE

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ACCORDING to the necrology statistics of the *Journal of the American Medical Association*, more doctors die of carcinoma of the prostate than of any other form of cancer, and it has been stated by Hugh Young that cancer of the prostate occurs in 14 per cent of all men past 44 years of age and that it is three times as common in men as is cancer of any other internal organ.

The problem of its treatment is thus one of prime importance. This consists in most cases of relief of urinary obstruction and palliation of the pain caused by metastasis or extension. Radium and x-ray therapy have not been found to be curative. Orchiectomy and the administration of diethylstilbestrol are very valuable in prolonging life and preventing pain, but are rarely curative. Cures are occasionally obtained when, after prostatectomy for supposedly benign prostatic hypertrophy, the diagnosis is made by the pathologist on the finding of a small malignant nodule in the removed tissue.

To Young belongs the credit for devising the first procedure which gives promise of cure in any case. In 1904, after careful study of the local anatomy, and after submitting his plan to Halsted, he performed his first radical operation for early carcinoma of the prostate. So thoroughly and carefully had he studied the problem and planned the procedure that his description of that first operation would serve as the operative note of the operation the last time he performed it, with only very slight alterations.

Since that time certain modifications have been suggested and practiced by various men, Geraghty, Lowsley, and Belt in particular. Belt uses a somewhat different approach and does not remove the apex of the prostate, because he thinks that in this way he causes less disturbance to the membranous urethra and the external sphincter. Geraghty and Lowsley attempted to preserve the internal sphincter, and Lowsley anastomoses the bladder neck and the membranous urethra by means of a plicating mattress suture of ribbon gut. But in the essentials and principles, the operation they all use is the one described by Young in 1904.

The operation has long had its strong advocates, among them George G. Smith, Randall, Hinman, Rolnich, Scannel, Belt, and Lowsley. Nevertheless, the profession has been slow to adopt it. In 1941 Thompson and Emmett stated that "during the past ten years at the Mayo Clinic we have not employed radical perineal prostatectomy in cases of carcinoma."

In 1942 it was stated in the *Journal of the American Medical Association*, in response to a query in the correspondence section, that once the diagnosis of carcinoma of the prostate was made, no surgical operation would produce cure. Although this statement brought letters of protest from various sources, it well illustrates the common attitude toward the problem.

Presented at the Third Annual Meeting of the Central Surgical Association, Chicago, Ill., Feb. 22-23, 1946.

In 1944 Cook wrote, "At present we are performing more than 1200 prostatic resections yearly by the transurethral method (at the Mayo Clinic) with practically total exclusion of any other form of surgical treatment. Kohler's work more recently has shown that the perineural lymphatics are involved rapidly by malignant lesions of the prostate, and this fact militates against removal of all carcinoma by any operative procedure."

In 1944, in discussing Young's last dissertation on the radical operation, the late Doctor Ballenger said, "All of us must agree that Dr. Young has given us convincing arguments in favor of complete perineal prostatectomy for patients who present themselves with early carcinoma of the prostate. If a reasonably high percentage of patients with early carcinoma of the prostate came to urologists, and if the urologists had the technical skill of Dr. Young in this type of work, the problem would not be a troublesome one. Other 'ifs,' however, must be considered: for instance, if you were the patient with early carcinoma of the prostate, complete perineal prostatectomy might be preferred in order to gain greater expectancy of life in spite of the possibility of loss of urinary control or of a vesico-rectal fistula. While, if I were the patient, the less radical procedure of orchiectomy with transurethral removal of obstructing tissue at the vesical neck might be preferred in order to escape the possibility of loss of control of urine or of a vesico-rectal fistula. This does not, however, mean that the ideal should not be sought; namely, complete removal of early cancer of the prostate even though a campaign be required in order to obtain prompt recognition of these lesions, and that urologists work to perfect their technique in complete perineal prostatectomy."

In 1944 Young reported the results of the 184 radical operations done at John Hopkins. There were twelve deaths, a mortality of around 6 per cent, and Young stated that there were nearly 50 per cent cures—and that incontinence was uncommon, particularly in the more recent cases, since they had adopted Vest's suggestion of a mattress suture from the bladder neck passing through the perineum so as to produce traction and not constrict the external sphincter.

George Smith reported 100 cases. Twelve of these patients are living with no signs of recurrence or metastases from five to eighteen years after operation and fourteen are living and well less than five years after. Six died of other causes and eighteen have not been traced. He stresses the fact that even though recurrence should take place, it presents itself high up in the region of the seminal vesicles between the bladder and the rectum and that recurrence of urinary obstruction is rarely seen. In this, he is supported by Colston, who in eighty-four cases, found recurrence of obstruction in only four. Smith advocated the use of the radical operation in some cases in which cure is improbable, because of the promise of freedom from recurrence of obstruction. Others who have reported series of cases are Lowsley, Randall, Hinman, and Rolnick.

Young and those who have used this operation have always insisted that the operation, to be curative, must be done early, preferably before any symptoms have appeared. Unfortunately, people have not been accustomed to consulting surgeons until symptoms arise, when it is practically always too late for

cure. Before World War II there was a movement toward periodic health examinations. This, during the war, to a large extent and of necessity due to the scarcity of medical men in civilian life, went into abeyance, but it seems to be reviving now, and it is probable that the net effect of the war will be a greatly increased interest in periodic health examination. Some of the larger corporations are providing that their executives have health surveys every year. This gives an opportunity for routine digital examination of the prostate in a group of men in whom there have been no symptoms. In the past six months from the executives of one corportion we have discovered two early carcinomas of the prostate.

Carcinoma of the prostate originates in the posterior lamella in the great majority of the cases and hence is accessible to the examining finger. It is therefore important that each patient have a careful rectal examination and that in any doubtful case the examination be repeated by a man with a trained and experienced finger. In the clinic at Henry Ford Hospital three cases at least were found by interns, who, feeling a slight irregularity, sent the subject to the division of urology for consultation.

A certain small proportion of cases originate deeper in the gland and these cannot be diagnosed by rectal examination early enough for radical operation to be curative.

I have performed this operation twenty times, the first time in 1931 and the last time very recently. The operation has been performed in the usual way. An inverted V incision is made in the perineum. The central tendon is cut, keeping the transverse perinea anterior, and the levator ani and recto-urethralis muscles exposed. Then the recto-urethralis is cut or dissected away, and levators retracted and cleaned off the posterior surface of the prostate, exposing the fascia of Denonvilliers. The suspicious nodule in the prostate is then located and a small piece excised. At this point the operation is interrupted while the pathologist makes a frozen section and reports its results. If the report is carcinoma, the lateral margins of the prostate are dissected from surrounding tissues, an easy procedure, and the rectum is pushed downward and dissected away from the fascia of Denonvilliers and the seminal vesicles. Then, at the apex of the prostate, the membranous urethra is dissected around and cut off close to the prostate. The tractor is inserted into the bladder through the prostatic urethra. The anterior surface of the prostate is then dissected down to the bladder wall and the prostatopubic ligament cut. The prostate is cut along the anterior midline, through the urethra to the bladder wall, which is grasped with Allis forceps. Then down each side the bladder wall is cut off close to the prostate, being grasped by forceps as the incision is made, until the edges of the trigone are reached. The trigone is cut across transversely and the bladder portion pushed up, off the vesicles. The vesicles are dissected up as far as possible and cut off, being removed in one mass with the prostate. Then a Foley catheter is inserted into the urethra, and passed into the wound and into the bladder. Two or three sutures of catgut, inserted by means of the boomerang needle, anchor the anterior wall of the bladder to the anterior wall of the membranous urethra. Then, using ribbon gut, Lowsley's plicating mat-

tress suture, inserted into the sphincter muscles, brings the rest of the bladder opening in contact with the membranous urethra, usually making a watertight closure. The Foley bag is supposed to remain in situ for about ten days. If it comes out, as has happened, it is very easy to insert another.

The greatest difficulty in the operation is caused by bleeding. When the prostate is cut away from the bladder wall there is constant troublesome bleeding. This combined with the narrowness and depth of the hole in which the manipulation must of necessity take place often makes the removal of the vesicles and the suture of the bladder to the urethra quite difficult.

The age of the patients has varied from 48 to 73 years, most being between 56 and 62, that is, in the years when development of carcinoma might be expected to be rapid. Most have been vigorous, active men, and have afterward returned to active life.

There have been no operative deaths and none showed much shock. Being vigorous men, few of them required any preoperative preparation and most were out of bed and walking soon after operation. Healing has usually been prompt and often there was no perineal leakage of urine.

The length of stay in the hospital following operation has been much the same as for a one-stage suprapubic prostatectomy or a conservative perineal prostatectomy. The shortest stay was eleven days. Nine patients stayed less than three weeks. Five stayed more than one month, but of those one fell and broke his jaw ten days postoperative; another had a rectovesical fistula and insisted upon remaining until attempt at repair could be made; a third had thrombophlebitis for which a femoral vein was ligated.

Six deaths have occurred so far among the twenty patients on whom the operation has been done, one six months, one three and one-half years, one six years, one seven years, and one nine years after operation. Four of these died of carcinoma. The one who lived seven years died of a cardiac condition. He showed evidence of metastases near the end of his life, although they caused no symptoms and played no role in causing death. The one who lived nine years died of carcinoma of the bowel with metastases to the liver. His local surgeon performed an exploratory operation, but unfortunately no biopsy was made, so we do not know whether this was a recurrence or an independent new growth.

Four patients are living five years or more after operation. One of these at the end of six years has a little swelling of the right leg and thigh of three or four months' duration. Whether this means recurrence remains to be seen. His health otherwise is excellent and he has no urinary symptoms.

There were ten patients living after less than five years; all of these are in good condition. One, on rectal examination, shows a palpable mass the size of the last phalanx of my little finger, to the left of the rectum and in the region of the vesicles, possibly a local recurrence although it is not hard and movable. I am positive at least three others will have recurrence or metastasis, for at the time of operation I felt that I had cut across cancer tissue in the bladder wall.

Of course, one would expect the sexual powers to be abolished by the operation, and this has been explained to the patients before operation inasmuch as at least one-half of the patients were still sexually active. Only one, the youngest of the group, has retained power of erection, but of course with no ejaculation.

Besides the mechanical difficulties met with, the two great bugbears for the operation are, *first*, the danger of injuring the rectum and having a resulting rectovesical fistula and, *second*, the danger of incontinence. I have injured the rectum once, about one year ago, and there is still drainage in this patient. I can obtain little information about the frequency of this accident and of the prognosis. I know of one such accident by another surgeon in a case of radical prostatectomy, and in that case the wound healed per primum with no resulting fistula. So far as urinary incontinence is concerned, I no longer fear it greatly. Some patients have satisfactory control from the start. Others acquire it in time, varying from a few days to three months. It has happened more than once that after the catheter is first removed the patient has been unable to void and the catheter had to be replaced for a period.

Of the twenty patients, none has had incontinence, at night; two, now dead, had permanent day weakness, particularly at the end of the day; sixteen had satisfactory control, at the worst, losing a drop or two under stress; one recently operated upon is showing improved control all the time; one has a rectovesical fistula, but I believe the urethral sphincter is competent. The last man operated upon left the hospital at the end of eleven days, with perfect urinary control, and returned to his work one month after operation.

Even if incontinence should occur occasionally, it should be considered one of the risks to be taken and I do not believe it is an argument against this operation, for it is seen after other operations. I have under my care three patients with incontinence following transurethral resections, one of my own doing and two done elsewhere.

The criteria for selection of patients suitable for this operation are important. First and foremost, there must be no evidence of metastasis or extension. The prostate must not be fixed to the pelvic wall and there must be no induration at the apex of the prostate involving the membranous urethra. Some extension to the lower part of the seminal vesicle is not a contraindication. In most of the cases there was only a suspiciously hard nodule in one lobe or the other. In a very few the whole gland was hard when felt per rectum. In all cases roentgenograms have been negative for metastases and in all recent cases the acid phosphatase of the blood has been normal. In doubtful cases with small borderline firm areas we have felt justified in advising diathermy for one or two months, and by this means we have ruled out carcinoma in several men without having a biopsy.

One man was sent in by his physician with the diagnosis of carcinoma. Rectal examination showed the whole prostate hard and irregular, but mobile, and with no evidence of extension or metastasis. For some reason he refused operation at first and was treated by diathermy for two months. There was no change, so radical operation was then performed. The pathologic examina-

tion showed involvement of the whole prostate, but the man was living and well with no evidence of extension or metastasis four years later.

In another man the diagnosis was made by the pathologist after a transurethral resection. At operation I felt that I had cut across a band of carcinomatous tissue in the bladder wall. The patient died three years later with metastasis.

Another man was followed for one and one-half years by us. We did not feel that the prostate showed carcinoma. He disappeared for three years and when he returned there was no doubt of the diagnosis. Radical operation was performed and now, two years later, he is well and has good urinary control. This illustrates well the slow growth of some carcinoma, shows the difficulty in claiming cures by any procedure, and throws some doubt on claims of cure even after five years.

The question of the use of stilbestrol to make borderline inoperable cases operable arises. We all have seen hard prostates soften and become smaller under stilbestrol treatment and it may be that stilbestrol may be useful in this way. Colston mentioned the possibility in one of his articles. At present, I have one such patient under observation. He is a man formerly seen regularly for a mild chronic prostatitis. Recently, after a lapse of three years he was seen again and the lateral portion of the left lobe was hard and fixed to the pelvic wall. He has now been on stilbestrol six weeks and the gland has softened and become mobile. Biopsy may be advised to be followed by radical prostatectomy if indicated. Among the twenty cases are two patients who had preoperative courses of stilbestrol. Both are alive but it is too early to draw any conclusion, and in one I feel reasonably certain the growth was not eliminated.

In only two patients, after hearing from the pathologist, have I refrained from performing the radical operation. The prostate was exposed in the usual way, a small piece of the suspicious area was removed, and the frozen section showed no carcinoma, therefore an ordinary conservative prostatectomy was done. In both of these, to my chagrin, the final report on the prostate was carcinoma.

I believe the fact that I have biopsied no truly benign prostates is an indictment of myself, for if I am to operate on early growths, I should certainly perform biopsies on some benign glands.

In conclusion, in view of the hopeless prognosis otherwise, the low operative mortality of the operation, the rarity of incontinence, and of rectovesical fistula following it, and the fact that apparently the operation even when it does not cure at least does not hasten metastasis and does prevent recurrence of obstruction, I believe the operation is useful and that it should be more widely used. A corollary to this is that the profession should be educated to recognize the early cases, and that men past 50 years of age should have the benefit of a careful rectal examination every year.

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PROSTATIC CARCINOMA

A Follow-Up on 795 Patients Treated Prior to the Endocrine Era and a Comparison of Survival Rates Between These and Patients Treated by Endocrine Therapy

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A NEW era in the management of prostatic cancer commenced in 1941, with the epoch-making discoveries of Charles Huggins who in that year demonstrated a functional relationship between this disease and certain hormones. Since that time physicians have treated patients suffering from carcinoma of the prostate by the administration of estrogenic hormones, by irradiation of the testes, and by surgical castration; and the series of cases that are being reported currently from many clinics will doubtless provide a means for final evaluation of the methods that are being employed.

Spectacular regression of the primary neoplasm has been observed in many of the patients, and in some instances complete disappearance of metastases has occurred, but some of the patients have shown improvement of short duration only and a few have apparently derived no benefit whatever from the endocrine modifications that have been employed. Some observers have suggested that carcinogenic activity in some cases might even be accelerated by the altered hormonal status that is being effected. It appears evident that a critical evaluation of endocrine therapy must take into consideration not only the spectacular remissions but also the failures, and must demonstrate as well, whether the change in hormonal status produces any instances of adverse response. Such a critical evaluation must have control series of cases not treated by the newer methods to serve as a base line for comparative study. There are few such series reported in the literature and those that are available are lacking in many of the statistical details essential to critical comparative analysis.

The present report deals with 795 cases of prostatic carcinoma diagnosed and treated in the University of Michigan Hospital between the years of 1925 and 1940. A follow-up system that has been operating to keep in close touch with these as well as other patients who have been treated in this clinic has given us the basis for the study. Ninety-eight and one-half per cent of the patients have been followed until death or are known to be now alive (Table I). Only 12 of the 795 patients (1.5 per cent) have been lost to follow-up. Data regarding the remaining 783 patients are thus available to us for statistical enumeration. In Table II is shown the distribution of the 737 patients who have been reported dead. Of these, 605 died of cancer of the prostate gland, while 60 died following operations and 67 died of other causes; 29 of the latter died of cardiovascular disease. Five of the patients died of unknown causes.

Presented at the Third Annual Meeting of the Central Surgical Association, Chicago, Ill., Feb. 22-23, 1946.

TABLE I. 795 CASES OF CARCINOMA OF THE PROSTATE (1925 TO 1940)

PRESENT STATUS	NO. CASES	PERCENTAGE
Alive	46	5.8
Dead	737	92.7
Not followed	12	1.5

TABLE II. 737 CASES OF CARCINOMA OF THE PROSTATE (PATIENTS DIED)

CAUSE OF DEATH		NUMBER OF CASES	PERCENTAGE
Carcinoma of the prostate		605	82.09
Other causes		67	9.09
Other neoplasms	7		
Cardiac	29		
Cerebral hemorrhage	9		
Accidental	3		
Other causes	19		
Operative or postoperative		60	8.14
Cause unknown		5	.68
Total			100.00

In order to interpret the figures in the tables and illustrations a definition of terminology is apropos. We have included numerical values in terms of arithmetic mean as well as median. Arithmetic mean is the average, while the median designates a point so chosen that one-half of the individuals in the series are on one side of it and one-half on the other. To illustrate the distinction between median and average (arithmetic mean), suppose five persons have ages, respectively, of 3, 4, 5, 7, and 11 years. The average age is 6 years; the median is 5. Each has a distinct statistical value.

Age Distribution.—In Tables III and IV is shown the age distribution at the time of diagnosis. The average age was 67.6 years, while the 50 per cent point, or median, was 68.4 years. The oldest was 89 and the youngest 33. The literature records cases of prostatic carcinoma in patients as young as 6½ years; and there have been many cases reported in patients under the age of 40. Two of our patients were under 40 and twenty-five were younger than 50 years of age.

TABLE III. AGE DISTRIBUTION BY DECADES (795 CASES)

AGE	NUMBER OF CASES	PERCENTAGE
30 to 39	2	0.3
40 to 49	23	2.9
50 to 59	120	15.1
60 to 69	312	39.2
70 to 79	287	36.1
80 to 89	51	6.4
Totals	795	100

TABLE IV. AGE DISTRIBUTION AT TIME OF DIAGNOSIS IN 795 CASES OF CARCINOMA OF THE PROSTATE

Arithmetic mean	67.76 years	
Median	68.36 years	
Extremes		
Youngest	33.5	1 case
Oldest	89.5	1 case

TABLE V. TIME INTERVAL IN 737 PATIENTS WITH CARCINOMA OF THE PROSTATE WHO DIED, REGARDLESS OF CAUSE OF DEATH

INTERVAL	NUMBER OF CASES	NO TIME FACTOR STATED	ACTUAL NUMBER OF CASES	ARITHMETIC MEAN	MEDIAN	EXTREMES			
						SHORTEST CASES	MO.	LONGEST CASES	MO.
From first symptom to diagnosis	737	37	701	30.6	12.46	15	1	1	370
From diagnosis to death	737	2	735	21.2	11.91	1	0	1	180
From first symptom to death	737	38	699	52.11	32.50	1	1	1	434

In Table V are listed the duration of symptoms prior to diagnosis, the time interval between diagnosis and death, and the time interval between first symptom and death. The average duration of symptoms prior to diagnosis in 701 cases was 30.6 months; the extremes being 1 month (fifteen cases) and 32 years; the median was 12.46 months. The average survival from diagnosis to death in the entire group was 21.2 months, the median (50 per cent point) was 1 year; the extremes were less than 1 month and 180 months (15 years). The interval between onset of symptoms and death regardless of cause or of therapy averaged 52 months, the extremes being 1 month and 434 months; the median was 32.5 months. Bumpus reported that among 485 patients seen at the Mayo Clinic who had no treatment whatever the average duration of the disease was 31 months.

TABLE VI. TIME INTERVAL IN ALL PATIENTS WITHOUT METASTASES AT THE TIME OF DIAGNOSIS WHO DIED, REGARDLESS OF CAUSE OF DEATH

INTERVAL	NUMBER OF CASES	NO INTERVAL STATED	ACTUAL CASES	MEAN	MEDIAN	EXTREMES			
						SHORTEST CASES	MO.	LONGEST CASES	MO.
First symptom to diagnosis	477	26	451	33.6	14.2	13	1	1	370
Diagnosis to death, regardless of cause	477	2	475	23.6	12.8	1	0	1	180
First symptom to death	477	28	449	57.6	38.0	1	1	1	434

The influence of metastases on the period of survival is of interest. Four hundred and seventy-seven (Table VI) of the patients had no evidence of metastases at the time of diagnosis. The average duration of symptoms prior to diagnosis in this group was 33.6 months, and 50 per cent of the group had symptoms for 14.3 months or less, the extremes being 1 month and 370 months. The survival following diagnosis averaged nearly 2 years while 50 per cent of the patients lived a little over 1 year; the extremes were less than 1 month and 180 months (15 years). The survival from the first symptom until death averaged nearly 5 years, the median being 38 months.

Patients who had clinical evidence of metastases (Table VII) at the time of diagnosis had a shorter survival than those who were free from metastases when first seen. There were 260 patients in the present series who had metastases at the time of diagnosis. The average duration of symptoms prior to diagnosis

TABLE VII. TIME INTERVAL OF ALL PATIENTS WITH METASTASES AT THE TIME OF DIAGNOSIS WHO DIED, REGARDLESS OF CAUSE OF DEATH

INTERVAL	NUMBER OF CASES	NO INTERVAL STATED	ACTUAL CASES	MEAN	MEDIAN	EXTREMES			
						SHORTEST CASES	MO.	LONGEST CASES	MO.
First symptom to diagnosis	260	11	249	25.1	12.3	2	1	4	240 (20)
Diagnosis to death, regardless of cause	260	0	260	16.9	9.6	31	1	1	176
First symptom to death	260	11	249	42.2	28.2	3	3	1	300 (25)

was 25 months, and 50 per cent of the patients lived approximately 1 year. The survival following diagnosis in this group averaged 16.9 months, with 50 per cent living 9.6 months or longer; the extremes were 1 month and 176 months. The longest survival occurred in a man who had metastases in the spine and pelvis at the time of diagnosis; he survived nearly 15 years.

There have been 605 who are known to have died of carcinoma up to the present time, and data on these patients are listed. Tables VIII and IX are

TABLE VIII. AGE OF 605 PATIENTS WITH CARCINOMA OF THE PROSTATE WHO DIED OF CANCER

BY DECADES		PER CENT
30 to 39	1	0.17
40 to 49	17	2.81
50 to 59	106	17.53
60 to 69	243	40.17
70 to 79	208	34.38
80 to 89	30	4.96
Total	605	100.00

TABLE IX. AGE OF 605 PATIENTS WHO DIED OF CARCINOMA OF THE PROSTATE

Arithmetic mean (average)	67.23 years
Median	67.82 years
Youngest, 1 case	37.5 years
Oldest, 1 case	87.5 years

concerned with age of the patients and indicate that the average age is similar to that of the entire series. The duration of symptoms is listed in Table X, which shows that time factors are not remarkably different from those of the entire series. The relationships of metastases to survival are listed in Tables XI and

TABLE X. TIME INTERVAL IN 605 PATIENTS WITH CARCINOMA OF THE PROSTATE KNOWN TO HAVE DIED OF CARCINOMA

INTERVALS	NUMBER OF CASES	NO STATED INTERVAL	ACTUAL CASES	ARITHMETIC MEAN	MEDIAN	EXTREMES			
						SHORTEST CASES	MO.	LONGEST CASES	MO.
First symptom to diagnosis	605	26	579	27.4	12.4	12	1	5	240
Diagnosis to death	605	0	605	22.5	13.0	26	1	1	180
First symptom to death	605	26	579	50.0	32.3	2	2	1	324

TABLE XI. STATUS OF METASTASES IN 605 PATIENTS KNOWN TO HAVE DIED OF CARCINOMA OF THE PROSTATE

METASTASES	NUMBER OF CASES	PER CENT
Metastases	231	38.2
None	273	45.1
Questionable	60	9.9
Not stated	41	6.8
Total	605	100

TABLE XII. INFLUENCE OF METASTASES ON SURVIVAL RATES IN 605 PATIENTS KNOWN TO HAVE DIED OF CARCINOMA

	NUMBER OF CASES	AVERAGE (MO.)	MEDIAN	EXTREMES			
				SHORTEST CASES	MO.	LONGEST CASES	MO.
Metastases	231	18.6	11.78	13	1	1	176
None	273	24.7	13.5	12	1	1	180
Questionable	60	24.2	14.5	3	2	1	173
Not stated	41	26.6	14.0	1	1	1	111
Total	605						

XII. It is interesting to note that the average survival following diagnosis is only 6 months greater in those patients that are free from metastases and the longest survival in each of the two groups differed by only 4 months. Tables XIII and XIV show details regarding the survival in the two groups of cases and are presented here for purposes of comparison with other series of cases. It is interesting to observe that survival rate at 72 months is only 5 per cent different in the two groups. In Table XV the 605 dead have been listed accord-

TABLE XIII. DEATH RATE FOLLOWING DIAGNOSIS IN 273 PATIENTS WITH CARCINOMA WITHOUT METASTASES

MO.	NUMBER WHO DIED	PER CENT DEAD
6	76	28
12	126	46
18	166	61
24	186	68
30	205	75
36	214	78
48	235	86
60	245	90
72	252	92
84	256	94
96	262	96
180	273	100

TABLE XIV. DEATH RATE FOLLOWING DIAGNOSIS IN 231 CASES OF CARCINOMA WITH METASTASES

MO.	NUMBER OF CASES	PER CENT
6	72	31
12	122	53
18	160	69
24	185	80
30	198	86
36	205	89
48	211	91
60	218	94
72	223	97
176	231	100

TABLE XV. SURVIVAL RATES BASED ON TREATMENT IN 605 PATIENTS KNOWN TO HAVE DIED OF PROSTATIC CANCER

TYPE OF TREATMENT	NUMBER OF CASES	AVERAGE ARITHMETIC MEAN	MEDIAN	SHORTEST		LONGEST	
				NUMBER OF CASES	MO.	NUMBER OF CASES	MO.
No treatment	239	18.6	8.4	25	1	1	176
Transurethral resection	231	24.0	17.3	11	2	1	134
Suprapubic prostatectomy	22	44.5	24	3	2	1	180
Simple perineal prostatectomy	5	38		1	3	1	173
Radium	7	35.1	18	1	7	1	132
Cystotomy	92	19.9	10	1	1	1	135
Young punch	7	37	31	1	21	1	69
Caulk cautery	1					1	111
Suprapubic + Young punch	1					1	12

ing to treatment as well as survival following diagnosis. These data demonstrate that the patients who had suprapubic or perineal prostatectomies enjoyed a much longer survival than those who had other operations. The reason for this greater survival probably lies in the fact that most of the patients so operated upon had lesions that were manifestly considered to be benign at the time of operation and were found to be malignant either at the time of operation or else by microscopic analysis. The survival of patients treated by transurethral resection was greater than that of patients who had no treatment whatever, and the conclusion may be permitted that: (1) the nonoperated lesions may have been more advanced than those resected; (2) transurethral resection prolonged the lives of many by relieving obstruction; (3) the resection operation probably did not cause acceleration of the malignant growth or extension by metastases.

TABLE XVI. TIME INTERVALS IN 46 LIVING PATIENTS WITH CARCINOMA OF THE PROSTATE

INTERVAL	CASES	NO INTERVAL STATED	ACTUAL CASES	MEAN	MEDIAN	EXTREMES			
						SHORTEST CASES	MO.	LONGEST CASES	MO.
Symptoms to diagnosis	46	2	44	33.8	24.0	4	1	1	185
Diagnosis to present checkup	46	0	46	108.3	93.5	2	58	1	216
First symptom to checkup	46	2	44	143.2	135.5	1	69	1	344

There are 46 patients alive today (Table XVI) out of the entire series of 795. These have all lived 58 months or longer since the diagnosis was made, the longest survivor being 216 months. These living patients are enumerated in Table XVII along with the treatment employed and the survival rates. The two patients that foot the list were both first operated upon by transurethral resection and the preoperative diagnosis in each instance was benign prostatic hypertrophy, but microscopic examination of the tissue revealed a few small areas of malignancy. In the first instance the resection operation was performed a good many years ago at a time when no effort was made to approximate a complete removal of the adenomatous tissue. At secondary operation the adenomatous mass was enucleated suprapubically without difficulty and the neoplasm, situated within the lateral lobe, was apparently all removed. The other

TABLE XVII. SURVIVAL FROM DIAGNOSIS TO LAST CHECKUP BY FORM OF TREATMENT IN 46 LIVING PATIENTS

TYPE OF TREATMENT	NUMBER OF CASES	ARITHMETIC MEAN	MEDIAN	EXTREMES			
				SHORTEST NUMBER OF CASES	MO.	LONGEST NUMBER OF CASES	MO.
No treatment	1					1	216
Transurethral resection	27	100.7	107	2	58	1	168
Suprapubic prostatectomy	2	94		1	84	1	110
Simple perineal prostatectomy	11	120.3	124.5	1	73	1	180
Radical perineal prostatectomy	2	75		1	72	1	78
Cystotomy	1					1	64
Transurethral resection + suprapubic prostatectomy	1					1	164
Transurethral resection + perineal	1					1	83
Grand Total	46	108.3					

TABLE XVIII. COMPARISON OF SURVIVAL IN ENTIRE CONTROL, ORCHECTOMY, STILBESTROL SERIES

	CONTROL (781 CASES)		ORCHECTOMY (75 CASES)		STILBESTROL (50 CASES)	
MONTH	PATIENTS DEAD	PER CENT DEAD	PATIENTS DEAD	PER CENT DEAD	PATIENTS DEAD	PER CENT DEAD
6	261	33.4	6	8	1	2
12	381	48.8	14	18.6	3	6
18	483	61.9	22	29.3	10	20
24	542	69.4	28	37.3	12	24
30	586	75.0	32	42.6		
36	610	78.1	41	54.4		
42	637	81.5	46	61.3		
48	648	82.9	50	66.6		
54	658	84.2				

TABLE XIX. COMPARISON OF SURVIVAL—PATIENTS WITHOUT METASTASES

	CONTROL SERIES (388 CASES)		ORCHECTOMY (45 CASES)		STILBESTROL (33 CASES)	
MONTHS	PATIENTS DEAD	PER CENT DEAD	PATIENTS DEAD	PER CENT DEAD	PATIENTS DEAD	PER CENT DEAD
6	106	27.3	2	4.4	0	0
12	168	43.3	6	13.3	2	6.0
18	211	54.3	8	17.7	4	12.1
24	233	60.0	14	31.1	5	15.1
30	255	65.7	15	33.3		
36	269	69.2	20	44.4		
42	282	72.6	23	51.1		
48	292	75.2	26	57.7		
54	300	80.0				

TABLE XX. COMPARISON OF SURVIVAL—PATIENTS WITH METASTASES

	CONTROL SERIES (260 CASES)		ORCHECTOMY (30 CASES)		STILBESTROL (17 CASES)	
MONTHS	PATIENTS DEAD	PER CENT DEAD	PATIENTS DEAD	PER CENT DEAD	PATIENTS DEAD	PER CENT DEAD
6	97	37	4	13.3	0	0
12	149	57	8	26.6	0	0
18	189	73	12	39.9	6	35.3
24	214	82	14	46.5	10	58.8
30	227	87	17	56.5		
36	234	90	22	73.1		
42	239	91				
48	240	92	23	76.4		
54	242	93				

patient, a 57-year-old physician, had an adequate 23 Gm. resection and three of the tissue fragments showed easily recognized malignancy. Radical perineal prostatectomy was advised and was performed twelve days following resection. The tissue removed at the second operation was subserially cut and no further evidence of neoplasm could be found. The patient is well today, secure in the knowledge that he has been cured of cancer.

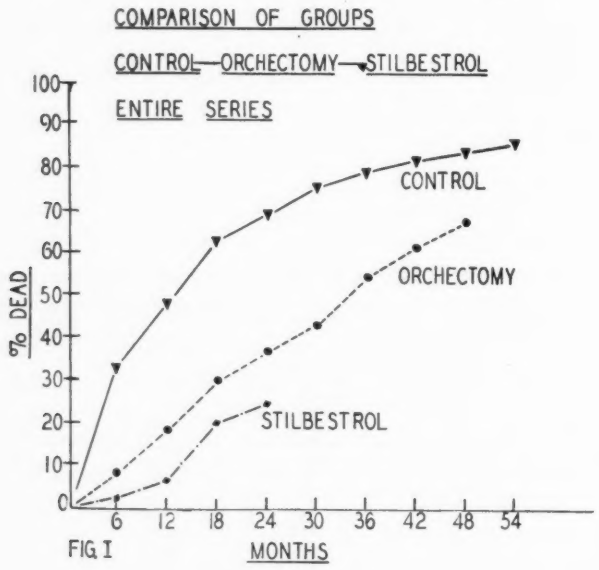

FIG. I

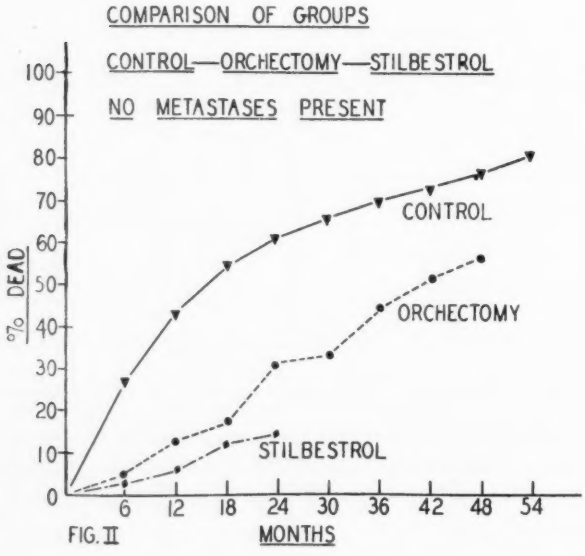

FIG. II

An investigation into some of the factors concerned with survival among those patients who lived 100 months or longer after the diagnosis was made discloses that fifteen of the patients had glands that were diagnosed rectally as benign hypertrophy or else had small nodules that aroused suspicion prior to

operation. The majority had cancers that were localized within the hypertrophic masses that were enucleated, or else had neoplasms of a low grade of malignancy, and the long survival among these fifteen cases is not at all surprising. The longevity of the remaining twenty patients who had glands that were easily recognized as malignant when palpated rectally is more surprising for six of the latter also had metastases when first seen, yet they lived 111 to 173 months following diagnosis.

The concluding part of the present study is concerned with comparing survival in patients treated by castration and by estrogen therapy with the control series. For purposes of statistical comparison we are permitted to use data on the control series up to a survival period of 54 months only, since there are 46 patients living in the series who have survived 58 months or longer. In Table XVIII is listed the death rate in the three series, including all patients, both

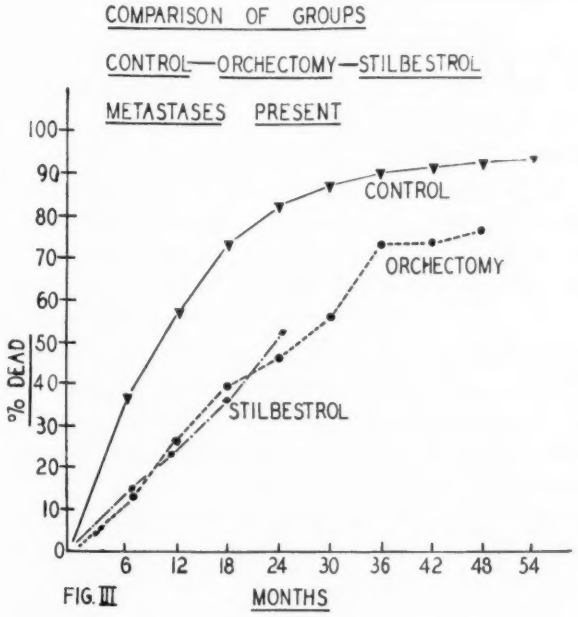

FIG. III

those with and those without metastases. These data demonstrate conclusively that the over-all survival is greater during the first 42 to 48 months in patients who have been treated by endocrine modifications, but sufficient time has not elapsed to allow a comparison of the final survival periods.

When the series are broken down on the basis of metastases at the time of diagnosis the cases are regrouped and listed (Tables XIX and XX).

SUMMARY AND CONCLUSION

1. The purpose of the present report has been to provide data on a large series of patients with cancer of the prostate who have been followed for periods up to 19 years since diagnosis.

2. The present series can be utilized for comparison with other series up to a point of 58 months survival; later follow-ups on this same series, when all

patients have died, will provide statistical data that can be then utilized for comparison with survival ratios of other series of cases taken at any period for study. It is our purpose to report on the present series again when complete data become available.

3. Comparative data at the present time indicate that survival rates are significantly prolonged by endocrine modifications in the series studied. Whether other or comparable series would show a similar advantage in favor of endocrine therapy of cases can only be the subject for speculation, but the comparative survival rates among patients with metastases suggests that castration or estrogenic therapy has a beneficial influence on the survival curve.

4. Only a comparison of final data on closed series of cases will disclose how the longevity of the greatest survivors in each series will compare and will settle the question regarding a possible acceleration of neoplastic activity in isolated cases by modifications of hormonal status.

MALIGNANT TESTICULAR NEOPLASMS

Analysis of 80 Cases

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THE induction of millions of young men into the Armed Services and their subsequent close medical supervision has concentrated in military hospitals a relatively large number of testicular malignancies in recent years. Much new interest in the subject has thus been stimulated and we have been moved to review the University of Michigan series of testicular neoplasms in an effort to elucidate several points. They are (1) to gain an estimate of the prognosis, and to lay down criteria of an adequate follow-up; to determine the significance of hormone assays as done in this clinic; (3) to judge the efficacy of early treatment; (4) to present trends in interpretation of material submitted to the pathologist.

This study is based on eighty cases of malignant disease of the testicle which were diagnosed at University Hospital and which have been followed for four years or longer. The question arises as to how long cases of testicular neoplasm should be followed before final outcome can be deemed reasonably certain; it was found in this group that of 56 persons ultimately dying from cancers, 2 lived more than four years, 1 more than five, and 1 more than six years. Therefore, any study based on a four-year follow-up is subject to roughly a 10 per cent error and any group followed for a shorter period is subject to a much greater deviation from the true final results.

In Table I is given the distribution of cancer according to age at the time of diagnosis. The youngest patient was 2 years of age, the oldest 66, and the average for the series was 35.7 years. Average duration of symptoms before diagnosis was 20.5 months; the shortest duration of tumor was 1 week and the longest 15 years. Of 79 patients in whom the side of involvement was specified, 48 tumors were in the right testicle, 28 in the left, and 3 were bilateral. Neoplasm in an undescended testicle occurred 4 times; no patient had had previous orchiopexy. There was gynecomastia in 3 instances; unilateral in one case and bilateral in the other two.

Attention should be called particularly to the 3 patients in this group whose presenting clinical picture and history closely resembled acute epididymitis. Such a situation is illustrated by H.S.C. (No. 469275), a white man 39 years of age, who sustained minor trauma to the left testicle on May 10, 1940, while lifting packages into his automobile. Pain and swelling in the left side of the scrotum soon followed, and the patient's local physician was first consulted on May 11, 1940, at which time a tentative diagnosis of epididymitis was made. However, the process did not respond to conservative treatment and operation was advised. Urine was collected for an Aschheim-Zondek test on May 15, 1940, and orchiectomy was performed on May 16. The hormone assay was subsequently reported to be positive and the sections of tumor tissue re-

Presented at the Third Annual Meeting of the Central Surgical Association, Chicago, Ill., Feb. 22-23, 1946.

TABLE I. AGE AT DIAGNOSIS

AGE (YR.)		NUMBER
1 to 15		3
16 to 40		47
41 and over		30
Oldest,	66	
Youngest,	2	
Average,	35.7	

vealed a malignant teratoma. The patient's convalescence was uneventful and at the present time there is no evidence of recurrence. The first manifestation of testicular neoplasm also sometimes closely mimics acute hydrocele, and every physician who treats urologic diseases should be on his guard lest this apparently innocuous process prove to be a far graver underlying disease.

TABLE II. LOCATION OF METASTASES PRIOR TO THERAPY

LOCATION	NUMBER
None demonstrable	51
Inguinal lymph nodes	4
Retroperitoneal lymph nodes	11
Mediastinal lymph nodes	3
Cervical lymph nodes	4
Lungs	15
Bones	2

Malignancies of the testes are known to metastasize early, although no dissemination could be clinically demonstrated in 51 of the group of patients when they first came under observation. In Tables II and III is shown the anatomic distribution of distant involvement before and after therapy. Nash and Leddy, Barringer, and others have made the statement that testicular cancer is one malignancy which can be cured by deep x-ray therapy. Two cases of the present number corroborate this opinion. The first of these, M.C. (No. 324850), age 39 years, was first seen in University Hospital on Nov. 1, 1933. The history of the illness dates back fifteen years to the time when he first noticed swelling in the scrotum. In the spring of 1933 the mass began to grow larger and there was onset of pain in the lumbar region of the back. On June 2, 1933, orchiectomy was performed by the patient's local physician and the specimen was sent to the pathologist at the University of Michigan. Diagnosis was malignant teratoma of testis, chiefly large round-cell sarcoma. He was examined at Mayo Clinic in September, 1933, at which time there was a large mass in the left upper quadrant of the abdomen, but roentgenograms of the chest and spine were negative. A course of external irradiation over the pelvis, abdomen, and chest was given.

TABLE III. METASTASES DEVELOPING SUBSEQUENT TO THERAPY

LOCATION	NUMBER
Inguinal lymph nodes	0
Retroperitoneal lymph nodes	27
Mediastinal lymph nodes	1
Cervical lymph nodes	2
Lungs	5
Bones	1
Operative site	2

On admission to University Hospital the mass in the abdomen was no longer palpable; chest roentgenograms were negative. A second course of deep irradiation over the pelvis, abdomen, and chest totaling 5,200 r was given during November, 1933, and a third series of treatments was administered during January, 1934, using the same roentgen dosage. On July 30, 1945, the patient reported himself to be well and without symptom of recurrent neoplasm.

The second example was that of a 52-year-old farmer, E. P. (No. 251981), who was first seen in University Hospital on Oct. 23, 1930, with a history of swelling in the lower right side of the abdomen first noticed fifteen months previously, but which had enlarged rapidly during the last three months. The right testicle had never been in the scrotum. Significant physical findings were right cryptorchidism and an infra-umbilical mass of grapefruit size. A course of three preoperative deep x-ray treatments of 500 r each was begun on Oct. 27, 1930, and on Nov. 1, 1930, an operation for removal of the tumor was performed. A portion of the operative note reads as follows: "There was a tumor mass lying in the right lower quadrant which was obviously testicle: 6 by 4 by 4 inches in size. There was a short broad pedicle which was dissected out, tied, and tumor removed. There was a large mass of metastatic glands retroperitoneally extending down to the pelvis and upward along course of ureter. One was removed for biopsy." The pathologist's report on the biopsied lymph node revealed malignant neoplasm of large round-cell alveolar sarcoma type. It resembled the similar neoplasm frequently found in the testis and was probably a malignant teratoma. The piece submitted showed adipose and connective tissue infiltrated with the same neoplasm. Postoperative deep irradiation to pelvis and abdomen totaling 2,600 r was given during November, 1930, and during January, March, April, and May, 1931. At a checkup examination in August, 1931, no evidence of recurrent neoplasm could be found. The patient was last seen in University Hospital during April, 1943, when he complained of mild dyspepsia. Physical examination revealed only arteriosclerosis with no evidence of neoplastic disease, and roentgenograms of the gastrointestinal tract, gall bladder, and chest were negative.

The ideas of various writers with regard to hormone assays on the urine have differed rather widely in the past. Ferguson once felt that the type of tumor that would be diagnosed microscopically and the presence of metastases could be rather accurately predicted in many cases from the prolan level. More recent work, however, by Dean, Hinman, and others indicates that a negative response for a test for prolan means nothing, but that a positive response dictates a grave prognosis. The titer of prolan *A* should be at least 500 mouse units, or luteinizing hormone should be present before the test is considered significant since low levels may be due to the follicle-stimulating hormone present in the urine of castrates. In Table IV are summarized fifty-four hormone assays made by injecting urine concentrate from the patient into mice. Only eight of eighteen pretherapy and ten of thirty-six post-therapy studies were significantly positive.

The question arose as to whether a tumor which gave rise to a negative Aschheim-Zondek test before therapy would ever cause a positive reaction after

TABLE IV. FIFTY-FOUR HORMONE DETERMINATIONS

	NEGATIVE	1 TO 500 MOUSE UNITS	500 + MOUSE UNITS	ASCHHEIM-ZONDEK POSITIVE	TOTAL
Pretherapy	6	4	5	3	18
Post-therapy	13	13	8	2	36
Total	19	17	13	5	54

TABLE V. HORMONE DETERMINATIONS BOTH PRE- AND POST-THERAPY (12 CASES)

PRETHERAPY TYPE OF REACTION	NUMBER	POST-THERAPY NEGATIVE	POST-THERAPY 1 TO 500 MOUSE UNITS	POST-THERAPY 500 + MOUSE UNITS	POST-THERAPY ASCHHEIM-ZONDEK POSITIVE
Negative	4	1	2		1
1 to 500 Mouse units	3		2	1	
500 + Mouse units	4	2	1		1
Aschheim-Zondek positive	1		1		

treatment. Since metastases from teratoma testis are often more malignant microscopically than the primary from which they originated, one would postulate an affirmative answer to this query. Aschheim-Zondek tests both pre- and post-therapy were available in the twelve cases which are charted in Table V. One negative test subsequently became positive, and one of very low titer became significantly high. Therefore, following a patient by hormone assays may be of value even though the pretherapy response was negative.

However, if the Aschheim-Zondek test is positive the outlook for survival is grave. Of eight patients having hormone levels above 500 mouse units before treatment, only two are living,* and all eight with positive determinations post-therapy are dead.

TABLE VI. TREATMENT

METHOD EMPLOYED	NUMBER
No therapy	7
Orchiectomy alone	19
X-ray therapy alone	5
Pre- and postoperative x-ray therapy	4
Orchiectomy plus x-ray therapy to abdomen	14
Orchiectomy plus x-ray therapy to pelvis	17
Orchiectomy plus x-ray therapy to abdomen and chest	10
Orchiectomy plus x-ray therapy to areas other than above	5

TABLE VII. RELATION OF MISCELLANEOUS FACTORS TO SURVIVAL

FACTORS CONCERNED	TOTAL NUMBER	NOW LIVING NUMBER	NOW LIVING PER CENT	NOW LIVING AVERAGE YEARS	DEAD NUMBER	DEAD PER CENT	DEAD AVERAGE MONTHS
Entire series	80	19	23.8	11.1	61	76.2	19.4
Metastases at time of diagnosis	29	2	6.9	12.3	27	93.1	6.8
No metastases at time of diagnosis	51	17	33.3	11.0	34	66.7	29.5
Pretherapy hormone level over 500 M.U.	8	2	25	8.5	6	75	7.3
Post-therapy hormone level over 500 M.U.	8	0	0	--	8	100	16.9

*One of these patients had chorionepithelioma and there is no recurrence after an elapsed time of twelve years since operation. The case is being reported completely elsewhere.

In Table VI are listed the methods of treatment employed; ideas as to adequate therapy have changed through the years, and consequently methods used are far from uniform.

In Table VIII are given data on survival with relation to various factors in treatment. Nineteen of these patients were treated by simple orchiectomy, and five (27.4 per cent) are alive after an average period of 9.3 years. Dean of New York, and Nash and Leddy of the Mayo Clinic, reported less than 10 per cent cures with simple orchiectomy, and the statement has been made that the per cent of cure with orchiectomy alone is no higher than the incidence of adult teratoma, a benign lesion, in other words, that mere orchiectomy cures virtually nobody. We heartily agree that persons with testicular malignancies other than chorionepithelioma should have postoperative x-ray therapy to pelvis and abdomen whether or not metastases can be demonstrated. And so small a group as five cures in nineteen patients does not furnish convincing proof that orchiectomy alone is adequate therapy, although our five patients who survived had malignant teratomas.

The assertion has been made that if neoplastic disease of the testicle could be diagnosed early enough, then a great many more of these patients could be saved through the benefit of early operation. Accordingly, the records of fifty-one patients without demonstrable metastases were divided into two groups: those who were treated within two months of onset of symptoms and those treated more than two months after the onset of symptoms. Six of ten treated "early" and thirteen of forty-one treated "late" are living. Application of the chi square formula to these figures reveals no significant difference and although one might assume that early treatment would yield better results, we were unable to prove that such is the case.

The use of preoperative irradiation to the testicle which is the site of a neoplastic process has been a point of considerable controversy, and a conclusive answer to the question can probably still not be given. Arguments against preoperative x-ray treatment are as follows: (1) The leaving in situ of a very

TABLE VIII. RELATION OF FACTORS IN TREATMENT TO SURVIVAL

FACTORS CONCERNED	TOTAL NUMBER	NOW LIVING			DEAD		
		NUMBER	PER CENT	AVERAGE YEARS	NUMBER	PER CENT	AVERAGE MONTHS
Orchiectomy alone	19	5	27.4	9.3	14	72.6	16.1
Preoperative, irridiation—orchiectomy and further irridiation	4	2	50	12.1	2	50	11.0
Postoperative irridiation to pelvis alone	17	5	29.4	12.4	14	70.6	33.6
Additional x-ray therapy subsequent to completion of original program of treatment	23	0	0	--	23	100	12.0
Treatment begun within 2 mo. of onset of symptoms (no demonstrable metastases)	10	6	60.0	9.3	4	40.0	10.5
Treatment begun more than 2 mo. after onset of symptoms (no demonstrable metastases)	41	13	31.9	11.0	28	68.1	29.5

malignant neoplasm which is known to metastasize early. As pointed out in the preceding paragraph we were unable to prove that a significant number of cases become incurable during the first two months of the disease, but neither was the converse verified, and certainly the possibility of early dissemination of the cancer cannot be denied. (2) The possibility of incorrect diagnosis because x-ray therapy sometimes renders subsequent microscopic interpretation difficult or impossible. The case for preoperative irradiation is most eloquently stated by the statistics of Dean, Ferguson, and others at Memorial Hospital who have the highest survival rate of any clinic in the country for a large series of neoplasms: 29 per cent of five-year cures in 172 patients, 72 per cent of whom had metastases at the time of diagnosis. However, these relatively good results might be due to the efficiency of postoperative irradiation rather than to the virtue of preoperative x-ray therapy, and a recent communication by Barringer indicates that they now favor orchiectomy without preoperative irradiation.

At the University of Michigan Hospital patients suspected of having neoplasms of the testicle are admitted to the ward at once, and orchiectomy is performed the following day after a sample of urine has been collected for hormone assay. At the time of operation the spermatic cord is exposed high in the scrotum, and clamped and cut before any manipulation of the testicle is permitted. Postoperatively the patient receives a course of x-ray treatments to the pelvis and abdomen.

In the literature one finds frequent mention of radical retroperitoneal lymph gland dissection for testicular cancer: the Chevassu-Hinman operation. It has been demonstrated that in 90 per cent of bodies there is a communication of the retroperitoneal lymph chain with glands above the renal pedicle and into the chest, and for this reason most surgeons have abandoned the procedure. Hinman reported that he had given up this operation, but Cahill of New York still employs it. It is reported that the Army at the present time is treating one-half of its patients by orchiectomy and irradiation, and the other half by orchiectomy, irradiation, and radical operation, so that if these cases can be followed, an adequate evaluation of the procedure should be available some five years hence.

In studying our series of cases one conclusive fact has been brought to light: that metastatic neoplasm which fails to regress or which becomes clinically evident following initial irradiation will not respond favorably to additional deep therapy. There were twenty-three of our patients who were given additional deep therapy to metastases which appeared subsequent to a full course of postoperative irradiation and not one was salvaged. The average survival of the group was twelve months. As previously shown, metastases at the time of diagnosis are occasionally apparently cured by irradiation; but any hope of palliation by deep x-ray treatments to lesions developing subsequent to adequate therapy is not well founded. Once adequately treated, the patient will either survive or perish and no further endeavor on the part of the physician will alter the outcome significantly except in the rarest instances.

In Table VII are recorded ultimate results for the entire group of cases. Of eighty patients, 23.8 per cent are living an average of 11.1 years after treatment. Two of twenty-nine individuals with metastases at the time of diagnosis have seemingly been cured by x-ray therapy. They have been followed 11.5

and 12.5 years, respectively, well beyond the period of probable recurrence. Fifty-one patients had no demonstrable metastases when first seen and their survival rate was 33.33 per cent.

For the clinician, chaos is the only word which adequately describes the present conflict of opinion regarding the pathology of testicular neoplasms. And for this reason no attempt has been made to correlate survival, method of treatment, and the pathologist's opinion of tumor tissue examined microscopically. The chief point of contention has always been the theory that all testicular tumors are teratoid in origin (advocated by Ewing and followers), versus the opinion of Chevassu and disciples who maintain that the seminoma is a distinct entity not arising from totipotent cells. And the old battle rages unabated. The Mayo Clinic group favors the Chevassu hypothesis, and feels that the seminoma of Chevassu, adenocarcinoma grade IV (Broders), embryonal carcinoma, embryonal carcinoma with lymphoid stroma (Ewing), monocellular carcinoma (Hinman), and spermatocytoma (Scholtz and Eisendrath) are all one and the same neoplasm. However, there is recent opinion emanating from the tumor registry in Washington, D. C., that seminoma and embryonal carcinoma are not identical, and that the former is only locally malignant and does not metastasize. This microscopic differentiation is extremely difficult to make, and in the past many errors in diagnosis have doubtless been made.

SUMMARY AND CONCLUSIONS

1. Data on eighty cases of malignant disease of the testicle which have been followed a minimum of four years are presented. Survival of the entire group is 23.8 per cent; and 33.33 per cent of fifty-one patients having no demonstrable metastases are now living after an average of 11.0 years.

2. Some cases of testicular tumor have an acute onset resembling epididymitis.

3. An occasional cancer of the testicle with metastases can apparently be cured by orchiectomy and x-ray therapy.

4. Only 33.5 per cent of fifty-four hormone determinations in this series displayed significantly elevated prolan levels; but a positive Aschheim-Zondek test adds to the gravity of the prognosis.

5. Additional x-ray therapy for recurrence after completion of the original program of treatment will very rarely, if ever, be curative and has very little palliative effect.

6. One patient with chorionepithelioma has been followed for twelve years after orchiectomy without evidence of recurrence.

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NOVOCAIN INFILTRATION IN THE TREATMENT OF ACUTE ANKLE INJURIES WITHOUT FRACTURE

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THE treatment of acute ankle sprains by procaine injection and immediate return to full activity has steadily increased in popularity since originally suggested by Arnulf and Frieh in 1934. The great war just ended brought into the armed forces millions of men who were subjected to a much more active physical life than they would have led as civilians. It was inevitable that both in the vigorous training courses and in the active combat zones, these acute ankle injuries should occur in large numbers and present a real problem in military medicine.

The years of experience using conservative measures including rest, local heat, contrast baths, and various types of supportive dressings have demonstrated that these ankle injuries usually require a period of from ten to fourteen days before the patient can return to full activity.

Moynahan, Alexander, Kiser, McMaster, and several other authors have reported series of acute ankle sprains without fracture treated by procaine infiltration and immediate return to full activity with excellent results.

It is generally conceded that all acute ankle injuries should be carefully x-rayed to exclude fracture before considering the patients candidates for injection therapy and return to full activity. Corathers and Hughes have independently called attention to that group of cases in which the calcaneofibular ligament is extensively torn permitting a rotation of the astragalus. Such an injury can be demonstrated by x-ray examination with the foot supinated as far as possible. It is well to check both ankles in evaluating the presence of an abnormal degree of rotation. If this is demonstrated, plaster fixation should be the treatment employed rather than injection without support.

Hyslop has reported three cases of superficial and common peroneal nerve injury associated with sprained ankles. In each instance the diagnostic features of weakness of the tibialis anticus, flabbiness of the muscles of the feet, and inability to extend the toes completely became apparent as the acute symptoms of the sprain subsided. Full recovery occurred in from one to six months in each instance with supportive therapy.

TECHNIQUE OF PROCAINE INJECTION

After the possibility of a fracture or abnormal rotation of the astragalus has been excluded by x-ray examination, the maximum points of tenderness about the ankle joint are carefully determined. It is extremely important to demonstrate these points accurately, and experience has shown that they may be sharply localized.

The skin is then prepared with soap and water and an antiseptic solution. It has been our custom to inject from 10 to 20 c.c. of a 1 per cent procaine

Presented at the Third Annual Meeting of the Central Surgical Association, Chicago, Ill., Feb. 22-23, 1946.

solution without adrenalin into each tender area. The injection sites are then gently massaged to diffuse the procaine and the foot is carried into all positions to demonstrate any residual discomfort. Satisfactory results can be expected only in those patients who obtain complete relief from pain on manipulation of the foot after injection.

A simple patch dressing is placed over each injection site but no supportive dressings are used. The shoes, tightly laced, are replaced and the patient is observed while he walks, stoops, and carries out various exercises to place the ankle joint in a variety of positions. With a satisfactory injection the patient experiences immediate and complete relief of pain.

Patients are always advised to keep active for several hours after treatment, being on their feet as much as possible. They are told that after twelve hours some stiffness or discomfort may return, particularly with rest, but this usually disappears with resumption of full activity.

Patients are re-examined in twenty-four hours and if symptoms have recurred, the ankle is again injected. If the pain is not completely relieved after two therapeutic trials, it is assumed that the patient is not a suitable one for this form of therapy.

REPORT OF CASES

In a previous communication, I reported the results of procaine injection therapy in a series of acute ankle injuries without fracture observed aboard a carrier during World War II. This series has been subsequently increased to sixty-nine cases, and these form the basis of this report.

Sixty-five of the sixty-nine patients were seen in an average period of ten hours after their injury occurred. Four patients did not report until one and one-half, two, five, and ten days after their injury, symptoms having persisted during this time.

TABLE I. ACUTE ANKLE SPRAINS (SIXTY-FIVE CASES)

Area of ankle		
Medial	1	(1.5 per cent)
Lateral	46	(71 per cent)
Both	18	(27.5 per cent)
Degree of pain		
Moderate	33	
Severe	28	
Very severe	4	

The sixty-five patients seen on an average of ten hours after sustaining an acute ankle injury are listed in Table I. The medial ligaments of the ankle joint were involved alone in only one case, the lateral ligaments alone in forty-six cases (71 per cent), and there was evidence of marked tenderness on both sides of the joint in eighteen cases. Two of these latter patients evidenced additional pain and tenderness over the insertion of the tendo achillis posteriorly. This completely disappeared with infiltration of the area, in addition to the medial and lateral aspects of the ankle joint.

Pain on motion and local examination prior to injection was graded as moderate, severe, and very severe.

The initial injection of procaine gave an excellent result in fifty-six cases, or 86 per cent, of the series (Table II). These men all returned to full work immediately, remained free from pain, and experienced no subsequent disability. One patient obtained only a fair result, graded at 50 per cent improvement. He was subsequently treated by a supportive dressing and within three days all symptoms had disappeared.

TABLE II. INJECTION OF PROCAINE

RESULTS	NUMBER	PER CENT
Primary injection (65) cases		
Fair	1	1.5
Excellent	56	86
Good (recurrence)	8	12.5
Second injection (8) cases		
Fair	1	12.5
Excellent	4	50
Failure	3	37.5

The remaining eight patients all received immediate relief following injection, but there was a recurrence of the initial pain and disability in from four to twelve hours. All of these patients originally complained of severe or very severe pain, and five were in the group with bilateral ankle tenderness. Reinjection of these eight patients within six to twenty-four hours after the primary infiltration gave an excellent and permanent result in four, a fair result in one, and was a failure in three (Table III).

TABLE III. ACUTE ANKLE INJURIES (THREE CASES)

CASES	CAUSE OF FAILURE
1	Fissure fracture of os calcis
1	Fracture of posterior astragalus
1	Extensive ligamentous tear (rotation astragalus)

A careful review of these three cases disclosed that a fissure fracture of the os calcis had been overlooked in reading the wet plates in one, a fracture of the astragalus in the second, and a very extensive ligamentous injury in the third. It is entirely probable, although not demonstrated at the time, that this third man's injury was of the type mentioned by Hughes and Corathers.

The additional four patients, first seen from thirty-six hours to ten days after their injury, were all treated by injection after the possibility of bony injury was excluded. An excellent result was obtained in one, a fair result graded at 50 per cent improvement with two injections was obtained in two, while there was no benefit in the fourth. It seems well established that maximum results may be expected with injection therapy only in those patients seen within twenty-four hours after injury.

CONCLUSIONS

The technique of procaine injection in the treatment of acute ankle sprains is outlined.

Excellent and permanent results were observed following primary procaine injection in 86 per cent of sixty-five cases seen within twenty-four hours after the occurrence of their injury.

Factors which may prevent this method of treatment from being successful are (a) delayed injection, (b) inadequate injection, (c) very extensive ligamentous damage, (d) bony injury not seen on reading wet plates.

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METABOLIC ALTERATIONS FOLLOWING THERMAL BURNS

VI. The Effect of Altering the Nitrogen and Caloric Intake or of Administering Testosterone Propionate on the Nitrogen Balance

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THE metabolic response which is encountered after a thermal injury or fracture in the previously healthy individual has been well described.[1-3] It follows a fairly characteristic pattern both in the experimental animal[4-8] and in human beings,[2, 9-11] and the studies which have been made demonstrate alterations from the normal in the hormone,[12-14] protein, [2, 8, 10, 11, 15-19] carbohydrate,[20-22] water,[1, 4, 23] and salt[4, 15, 23, 24] metabolism, not only following trauma but also in various diseased states. It has been pointed out[2, 8-10, 19, 25] that the magnitude and duration of the metabolic alteration is largely dependent on the severity and type of injury, and the patient's ability to respond (nutritional state, sex and age, therapy employed, and subsequent complications). The type of reaction which is encountered following a severe injury is summarized in Fig. 1. It can be seen from this diagram that there is a marked negative nitrogen balance (this nitrogen deficit may last from five to fifty days), temporary elevation of the blood sugar[20-22, 26] and amino acid concentrations,[26, 27] a tendency to retain salt, and an increased intake and output of water with an actual retention of it. There is apparently a temporary increase in the urinary excretion of 17-ketosteroids[12] while the amount of cortin excreted[13, 14] is above normal for a longer period of time.

The purpose of this paper is to summarize briefly the impressions gained in the course of studying the metabolic response of forty-five burned patients and a group of animals with standardized experimental burns. This report will be largely confined to the effect on the nitrogen balance of altering the food intake or of administering a nitrogen-retaining hormone (testosterone propionate 25 mg. daily),* since other studies[23, 28, 29] have dealt with some of the other aspects of the problem.

RESULTS

In a previous publication[11] the methods employed in carrying out the study and the effect of a low or basal caloric and protein intake, or of a high caloric

Work done under contract with the Office of Scientific Research and Development. It was aided in part by a grant from the Theodore A. McGraw Fund for surgical research.

Presented at the Third Annual Meeting of the Central Surgical Association, Chicago, Ill., Feb. 22-23, 1946.

*The testosterone propionate used in this study was kindly supplied by the Ciba Pharmaceutical Products, Inc., Lafayette Park, Summit, N. J.

and protein intake, in burned patients was described. The results were for the most part in agreement with the findings of others.[9, 16-18] A response which was fairly typical was encountered in these patients and the usual result is summarized in Figs. 2, 3, and 4.

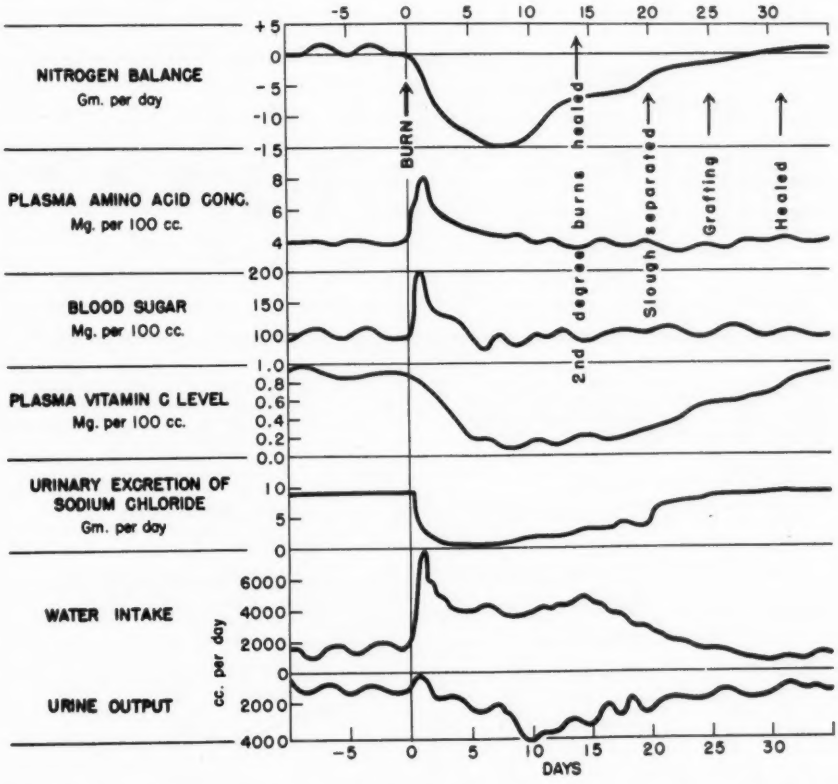

Fig. 1.—A schematic representation of the metabolic alteration that occurs following a severe injury.

In Fig. 2 it should be noted that the burned area was fairly large, and when an approximately basal caloric and protein intake was given, that the negative nitrogen balance persisted for at least thirty days. In the next case (C. L., Fig. 3) the burn was a rather mild one, the caloric and nitrogen intake very large, and the nitrogen deficit minimal. In Fig. 4, the burn was of moderate severity, the forced feeding poorly tolerated, and the nitrogen deficit possibly reduced but definitely not relieved. It has been demonstrated[30, 31] that from 1 to 10 Gm. of nitrogen may be lost from the wound daily so the first two patients (Figs. 2 and 3) would undoubtedly have had a greater nitrogen deficit than is shown. While in some cases (Figs. 3 and 4) it was possible by means of a very high caloric (60 to 90 calories per kilogram) and high protein intake to prevent or to minimize the nitrogen loss, the clinical course of such patients was such (vomiting, diarrhea, edema, etc.) that it was felt inadvisable to force these patients to take large quantities of food at least during the first ten days (catabolic phase).

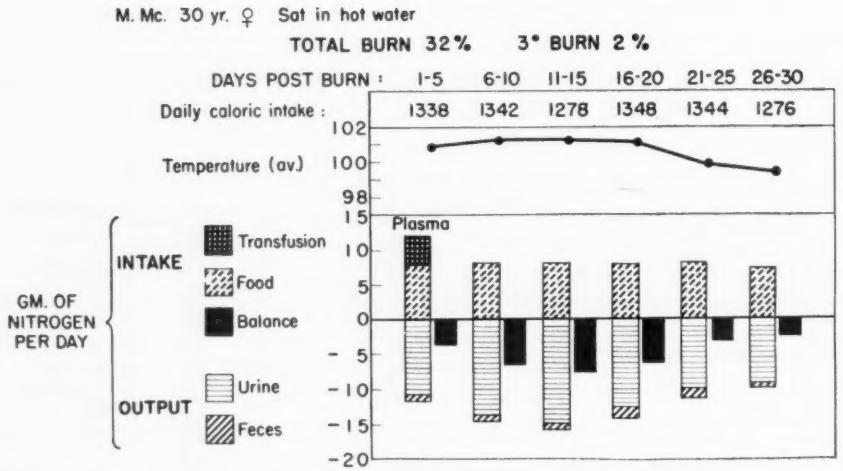

Fig. 2.—Nitrogen balance studies in a burned patient on an approximately basal caloric and protein intake.*

*Since there is a lack of knowledge regarding the exact way in which nitrogen administered in the form of transfusions of plasma or blood is utilized, the nitrogen derived from this source is shown in the intake column but omitted in the calculation of the nitrogen balance. This applies also to Figs. 3 to 9.

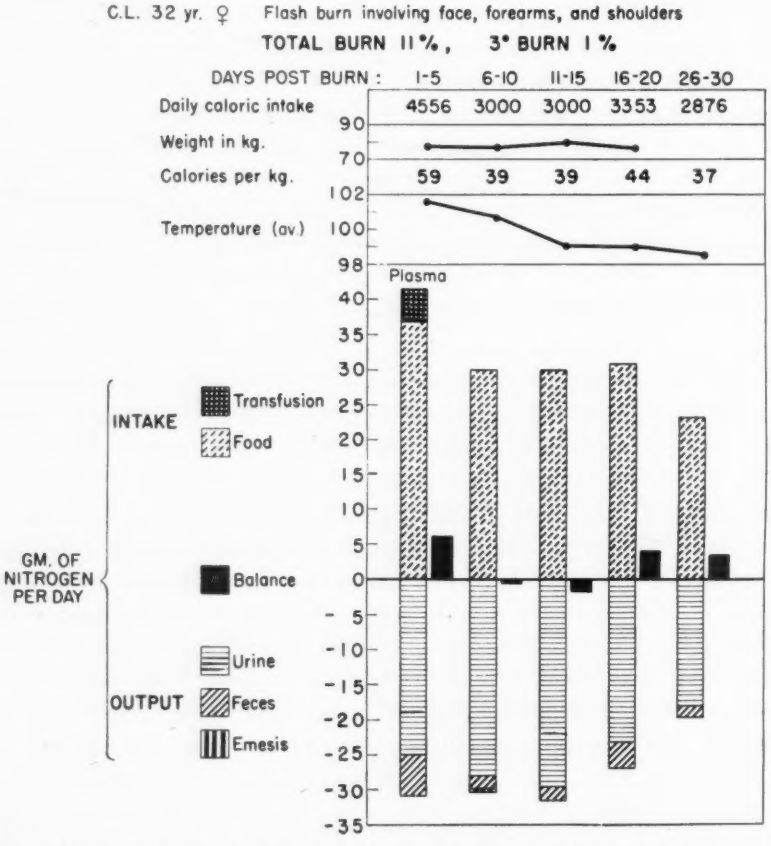

Fig. 3.—Nitrogen balance studies in a burned patient on a very high food intake.

It has been our impression that in the moderate and severely burned patients the nitrogen deficit is as a rule more marked than in those with a smaller burn, and that attempts to force feed the patients which show the greatest loss are usually met with the most difficulty.

Since it was not practical and apparently inadvisable to give burned patients a very large diet, it was decided to try a diet containing 1.6 times the basal caloric requirement (20 per cent protein). As a rule this level of food intake, which was started on the third day after the burn, was quite well tolerated in the majority of patients. It was only in the very severely burned patients that this diet had to be further reduced. The caloric intake during the first two days of therapy was made up entirely of carbohydrate feedings. When such a diet was given, the nitrogen loss seemed to be kept at a minimum and the return to a positive nitrogen balance occurred earlier than in those patients receiving a lower caloric and protein intake.

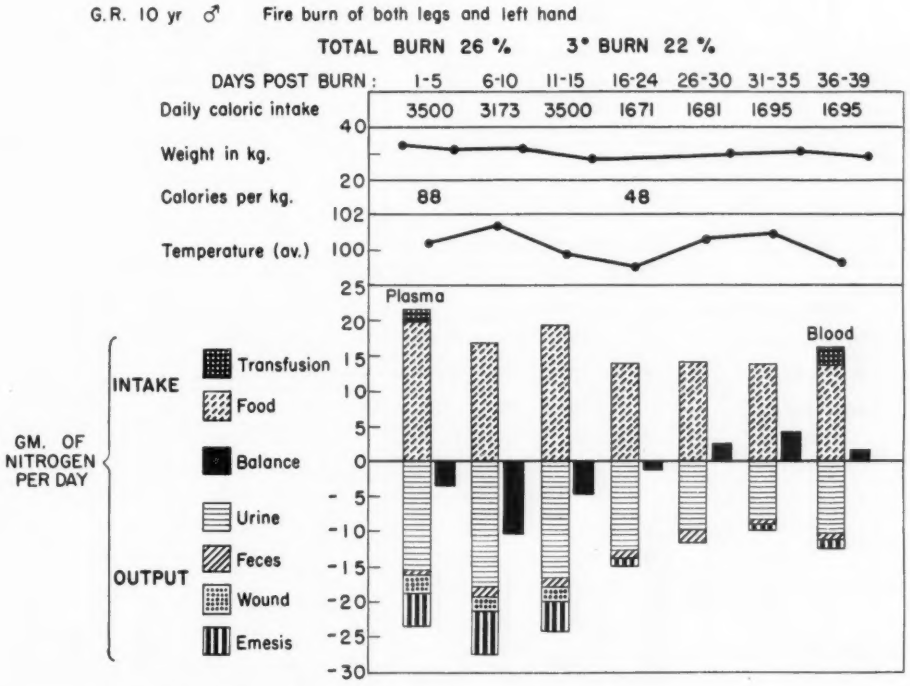

Fig. 4.—Nitrogen balance studies during a period of forced and normal feeding in a young boy following a moderately severe burn.

In Fig. 5 is demonstrated the effect of the 1.6 diet in an 11-year-old boy with a moderate burn. Since the patient was not given any protein orally during the first two days, his nitrogen deficit during this time was quite large. Subsequently, while under the 1.6 regime he did quite well when one considers the severity of his injury.

The results of a moderate caloric and protein intake in a previously healthy 26-year-old woman are shown in Fig. 6. Aside from the first and fourth periods the patient was in positive nitrogen balance. On the first day of the

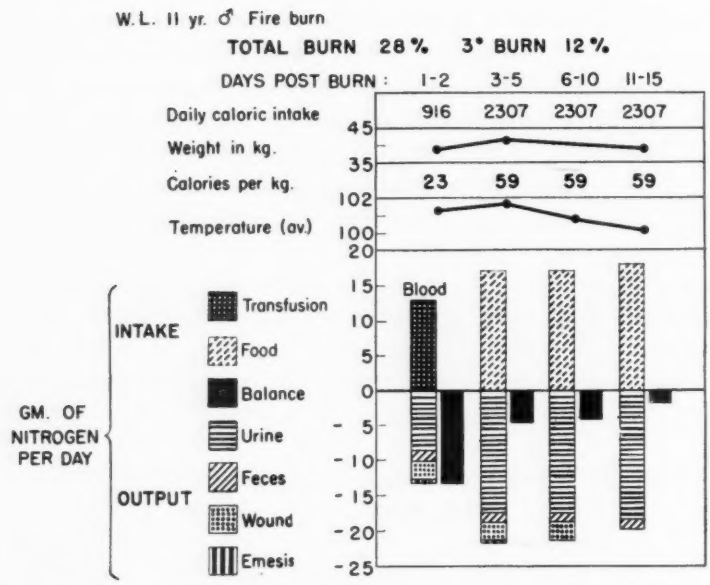

Fig. 5.—The results observed following a moderate (1.6 times basal) caloric and nitrogen intake.

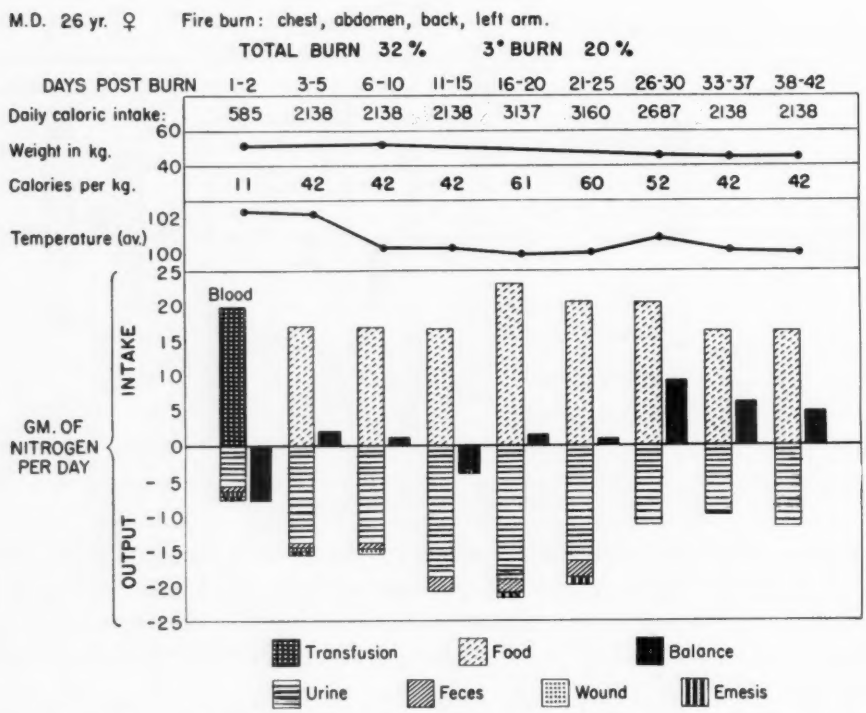
M.D. 26 yr. ♀ Fire burn: chest, abdomen, back, left arm.
TOTAL BURN 32% 3° BURN 20%
DAYS POST BURN 1-2 3-5 6-10 11-15 16-20 21-25 26-30 33-37 38-42
Daily caloric intake: 585 2138 2138 2138 3137 3160 2687 2138 2138
Weight in kg.
Calories per kg. 11 42 42 42 61 60 52 42 42
Temperature (av.)
GM. OF NITROGEN PER DAY
INTAKE
OUTPUT
Blood
Transfusion
Food
Balance
Urine
Feces
Wound
Emesis

Fig. 6.—The nitrogen balance studies in a burned patient on a moderate caloric intake.

second period, and throughout the fifth and sixth periods, an increased diet was given which caused an occasional emesis. This patient, as well as others who were more severely burned, demonstrates the difficulty of exceeding a moderate food intake during the first two to three weeks.

In Figs. 7, 8, and 9 are shown the results which were obtained following the administration of 25 mg. of testosterone propionate daily. B. S. (Fig. 7) was a 29-year-old Negro woman who showed only a slight nitrogen deficit which became positive when additional food was given on the twenty-first day. M. G. (Fig. 8) and J. S. (Fig. 9) were given a higher food intake plus testosterone propionate and showed essentially normal nitrogen balance studies. While all of these patients did well it is felt that the use of such a regime in more severely burned patients is needed before any definite conclusions can be made. It should be remembered that these patients and others (M. D., Fig. 6) showed periods of a positive nitrogen balance or periods of only slight nitrogen deficit, when only the 1.6 diet was given. Thus it is difficult to evaluate the effect of the hormone therapy.

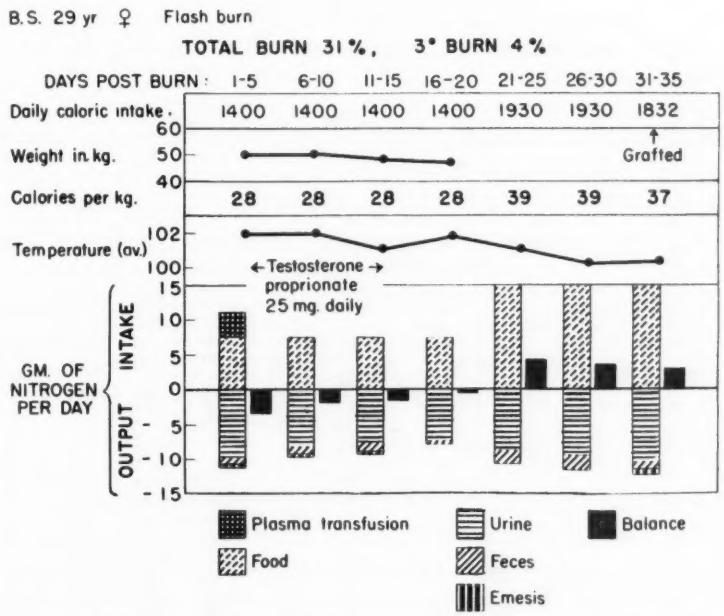
B.S. 29 yr ♀ Flash burn
TOTAL BURN 31%, 3° BURN 4%
DAYS POST BURN: 1-5 6-10 11-15 16-20 21-25 26-30 31-35
Daily caloric intake. 1400 1400 1400 1400 1930 1930 1832
Weight in kg. 60 50 40
Grafted
Calories per kg. 28 28 28 28 39 39 37
Temperature (av.) 102 100
←Testosterone→ proprionate 25 mg. daily
GM. OF NITROGEN PER DAY
INTAKE
OUTPUT
15 10 5 0 - 5 - 10 - 15
Plasma transfusion
Food
Urine
Feces
Emesis
Balance

Fig. 7.—The effect of ten days of testosterone propionate therapy and a basal diet on the nitrogen balance studies.

In four cases the carbohydrate content of the diet was significantly raised after a preliminary five-day period on a moderate diet. There was no evidence in these patients to indicate that the added sugar caused a significant nitrogen-sparing effect.

It has been shown by Croft and Peters[32] that the urinary nitrogen was substantially reduced when dl-methionine was supplemented to a normal diet following an experimental burn in rats. During the course of our study one patient and several animals were treated with a moderate caloric and protein intake, and dl-methionine, in an amount equal to 1 per cent of the diet. While

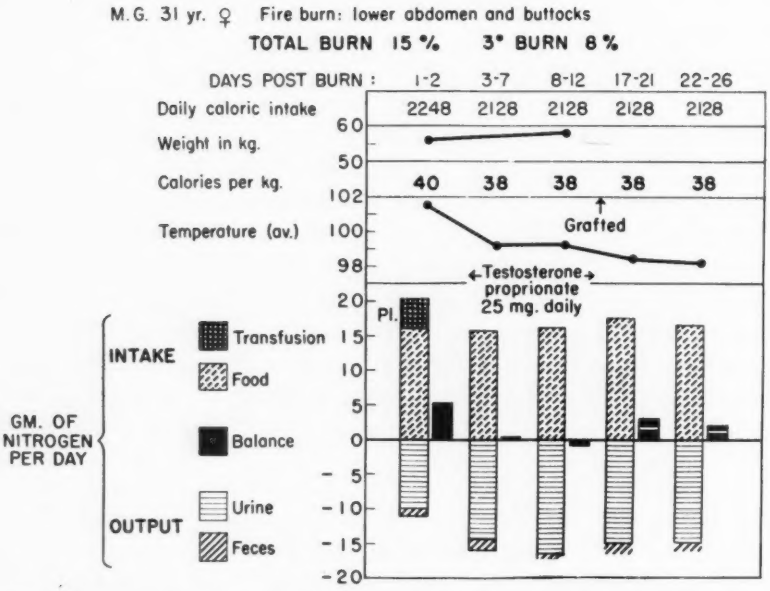

Fig. 8.—The effect of testosterone propionate and a moderate caloric intake on the nitrogen balance in a woman with a mild burn (since fecal nitrogen was not determined in the fourth and fifth periods it was estimated, thus reducing the positive nitrogen balance by about one-half).

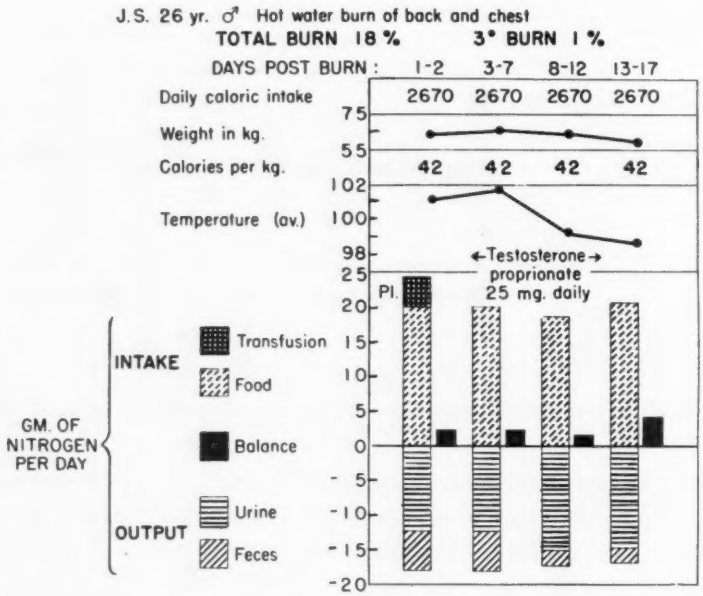

Fig. 9.—The effect of a moderate caloric and protein intake and testosterone propionate on the nitrogen balance of a mildly burned previously healthy man. The nitrogen lost from the wound was not determined, but if this had been added to that lost it was thought that the patient would have been approximately in nitrogen equilibrium.

the number of cases is too small to make any definite conclusions our results were in accord with those of Schenker,[18] who also apparently failed to confirm the findings of Croft and Peters.

COMMENT

Some workers[17, 33] have felt that in burned patients, the severity of the nitrogen deficit bears a direct relationship to the extent and severity of the surface area injured. On the other hand, it has been shown by other workers[2, 8-11, 18, 19, 25, 34] that the extent of the nitrogen deficit in burns or following other forms of trauma is also dependent on other factors, such as sex, age and nutritional state of the injured individual, extent of fever, infection, and other complications, and the type of therapy employed. Our studies seem to confirm the latter impression and also indicate that women and some children often showed changes which are not as severe as those occurring in the healthy adult man.

There has been some controversy over whether the nitrogen deficit could be combated effectively by increasing the caloric and nitrogen intake. It has been advocated[35-37] that high diets (3,000 to 5,000 calories containing 100 to 300 Gm. of protein) be given as soon as possible. On the other hand, Howard and associates[10, 25, 34] and Cuthbertson[2] believed that following trauma high caloric, high protein diets do not appreciably spare nitrogen during the catabolic phase. Levenson, Davidson, Lund, and Taylor[17] stated that it is important to supply adequate nutrition at the earliest possible moment, but also they say that in their cases no attempt was made to force the nitrogen intake in a well-nourished individual during the first week. Our study[11] indicated that in some instances the nitrogen deficit during this early period could be reduced by a high food intake, and the results presented in Figs. 3, 4, 5, and 6 lend support to this view. It was also apparent that very high intakes orally are not well tolerated in moderate or severely burned patients during the first week and in some of the cases studied, and in animal experiments, it has been shown to be deleterious during the catabolic phase. It therefore seems that a very high diet might somewhat alter the state of nitrogen balance but that during the early postburn period it is of little benefit and may prove harmful. However, when the anabolic phase of the reaction occurs or the peak of the catabolic phase has passed, the diet should then be gradually increased from a moderate level to as high a caloric and protein intake as the patient will comfortably tolerate.

Eight burned patients were given testosterone propionate (25 mg. daily for ten days) and while the results did not establish conclusively the value of such therapy they did indicate that a further trial would be advisable.

Four patients received an approximately basal caloric intake and testosterone propionate, while four other burned patients were given a diet containing 1.6 times the basal caloric requirement and testosterone propionate. The latter group showed the best results of all the patients studied. It has been shown[38] in normal individuals on a starvation regime (permitted 1,000 c.c. of water) and in patients on an inadequate caloric intake, that the admin-

istration of testosterone propionate reduces the loss of urinary nitrogen, but apparently because of a poor caloric and protein intake does not restore the individual to a positive nitrogen balance. Therefore, from these results and our experience, it would not seem desirable to employ the nitrogen-retaining hormones as a substitute for food, but to use them in an attempt to conserve and to utilize better the maximum diet which the patient can tolerate.

It should be remembered that masculine characteristics might be produced in the woman if too much testosterone propionate is employed. Since a reduction in the amount of urinary nitrogen and a gain in body weight occurs following its administration in normal subjects[39, 40] of both sexes, as well as in patients with cancer of the stomach,[40] hyperthyroidism,[41] Cushing's,[3, 42] Simmonds',[43] and Addison's disease,[44, 45] hypogonadism,[46, 47] and in a case of nephrosis,[48] it seems worthy of a further clinical trial. However, since it has been shown[49, 50] that large doses (more than 500 mg. per month) may cause temporary amenorrhea, hirsuitism, acne, and hoarseness in the woman, and since there is a tendency for such changes to occur in women following a thermal injury without the use of androgens, such therapy should be employed cautiously. Since in other disorders the amount of nitrogen excreted in the urine can be reduced effectively by giving 12.5 mg. daily,[41, 46] it would therefore seem worth trying such a dose in burned patients. Such therapy should also be more effective in improving the state of nitrogen balance after the catabolic phase of the reaction had subsided (eight to fourteen days). It has also been demonstrated in normal[39] and diseased subjects[44, 47, 48] that this form of therapy causes a mild to moderate retention of water and salt. Since the severely or moderately burned patient retains fluid during the catabolic phase, it might be preferable in some instances to institute therapy one or two weeks after the burn.

CONCLUSIONS

1. Following a thermal injury, a fairly characteristic metabolic response (Fig. 1) is illicited which is dependent on the nature and severity of the injury and on the individual reaction of the patient (sex, age, previous nutritional state, therapy, complications, etc.).

2. The giving of large diets (3,000 to 5,000 calories containing 100 to 300 Gm. of protein) does not seem advantageous during the catabolic phase following a burn even though the nitrogen deficit can at times be minimized. In fact, such therapy seems to be harmful when given during the first week or two.

3. Diets containing 1.6 times the basal caloric requirement (100 to 150 Gm. of protein) seemed to be tolerated quite well in the average patient, and while there was a good deal of individual variation, these patients had a smoother clinical course than did those on a higher intake; they maintained weight better and showed a smaller nitrogen loss than did the patients treated on a lower food intake.

4. There is some evidence to indicate that testosterone propionate may be of value in the treatment of thermal injuries, although further work along this line is necessary before such therapy could be advocated for routine use.

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